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The Chicago drainage canal is being given considerable attention now, owing to the fact that proposals for a part of the work are now being advertised for. These proposals are to be opened on June 8, and the contract requires the commencement of work within 30 days of the award. The route which is to be contracted for is mainly north and west of the Illinois & Michigan Canal, and generally north and west of the Des Plaines River. It crosses the bends of the river, especially where they extend any great distance to the northwest. The route from Chicago to Willow Springs is as yet undetermined. Mr. Williams, the Chief Engineer, has requested the Drainage Board to appoint a board of engineers to decide upon any questions of controversy which may come up after the contracts have been awarded.

A triple expansion, three crank rocker, high service pumping engine is to be built by the city of Boston. Bids for its construction will be received until May 12, as advertised in our columns for the past two weeks. The engine will be built after drawings by Mr. E. D. Leavitt, Consulting Engineer. It will have pistons 13 7-10 ins., 24 3-8 ins. and 39 ins. in diameter, of 6-ft. stroke. There will be three double-acting inclined pumps, having plungers 17½ ins. in diameter, 4-ft. stroke, with Riedler patent valve gear. The normal speed of the engine will be 50 revolutions per minute, which will give a capacity of about 20,000,000 gallons per day. The pressure pumped against will be about 55 lbs. per sq. in. Specifications can be obtained from Mr. Wm. Jackson, Cy. Engr.

The bill to amend the Interstate Commerce law, introduced into Congress by Representative Storer, of Ohio, has, with some amendments, been reported favorably by the House Committee on Commerce. The principal objects sought to be attained by the bill are greater expedition and less circumlocution in bringing cases to an issue in the courts, and the removal of penalties on shippers who are parties to violations of the law so as to meet the recent decision of the United States Supreme Court, which held that a man need not answer questions relating to violations of the law if they tended to incriminate him, thus preventing the Government from using shippers as witnesses. The following are in substance the principal changes made in the existing law by the bill: It makes the tariffs, schedules, and reports, which under the law must be furnished the Interstate Commerce Commission, records in the legal sense, so that copies of them, certified by the Commission, may be used as evidence without the necessity of sending a man to testify that the copy produced is the original. It makes the corporation, which is a common carrier, itself indictable and punishable by fine for all offenses. At present only employees, directors and officers are responsible. It strikes out the provisions inserted in the Fiftieth Congress in the original Interstate Commerce law by which the penalties provided for violations of the law were extended to shippers of goods as well as to the carriers, being a return to the original act. It then makes the testimony of witnesses taken by the Commission, after due notice to all parties and an opportunity given for cross-examination, final in that case, so that the matter will not be reheard by the courts, but the testimony taken by the Commission will be considered the same as though taken before a Master in Chancery. It preserves all the rights to trial by jury as guaranteed by the Constitution, but gives precedence both in the trial and appellate courts to Inter-State Commerce cases over all civil business.

The most serious railway accident of the week was the derailment of a cattle train on the Central Vermont R. R. at Des Rivieres, Que., April 24. The derailed train caused the wreck of an iron bridge, and the engine and tender went into the river. One man was killed.—An eastbound passenger train on the Southern Pacific Ry., was derailed by cattle on the track near Yuma, Ariz., April 21. One man was killed and four were injured.

A singular bridge accident occurred April 11 at Union Furnace, Pa., on the Pennsylvania R. R., one span of a bridge being wrecked by rock blasted from a new cut. For the following particulars we are indebted to Mr. O. E. McClellan, Superintendent of the Middle Division of the Pennsylvania R. R.: The bridge was of two spans, and its total length between back walls was 169 ft. 9 ins., the damaged span being 78 ft. 6 ins. in the clear. It was a half-through span with Wilson's triangular truss, built of cast and wrought iron. The bridge was one of the oldest on the division, and for some time past has been trestled, as it was considered rather too light for the present service. At this place grading is in progress for a change of line and it is necessary to make a heavy limestone cut. The accident was caused by a blast from this cut, which was let off at almost the highest point thereof, about 125 ft. above the grade and about 225 ft. distant from the bridge. The west span was practically destroyed and has since been taken down. The temporary trestling above mentioned supported the bottom chord and floor system, and consequently it was a comparatively easy matter to put in additional supports to carry the track temporarily.—A derailed car caused the wreck of a trestle on the Illinois Central R. R., near Milan, Tenn., April 8. Mr. N. D. Wiggins, Division Superintendent, states that the trucks were derailed about 300 ft. from the structure, and that the trestle was in first-class condition. Eight cars went down and were wrecked.

The Memphis bridge across the Mississippi River was practically completed at 7:30 p. m., April 24, when the last of the lower chord sections of the last unfinished span were placed.

A dry dock is to be built at the Puget Sound Naval Station, and the Navy Department, Washington, is about to advertise for bids for the construction. The dock will be 605 ft. long with 30 ft. draft of water. The body will be of timber and the entrance of concrete and masonry. The work will include a pump house, pumping plant, floating gate, culverts and other works. The plans and specifications have been prepared by Mr. M. S. Endicott, Civil Engineer, U. S. N., and provide for a dock of a form recently patented by him. We shall publish drawings and details in a later issue.

The iron highway bridge over the Missouri River at Great Falls, Mont., is practically completed. The structure is 1,056 ft. long, and consists of six 150-ft. spans, one 132-ft. span, and two 72-ft. spans. It is supported on iron pillars resting on masonry piers. The roadway is 20 ft. wide, with a flooring of 3-in. plank, and there is one 6-ft. sidewalk. The contractors were the Canton Bridge Co., of Canton, O.

An offer to light the Baltimore Belt R. R. tunnel at Baltimore, Md., has been made by the Thomson-Houston Electric Co. The company offers to equip the tunnel with the necessary plant for electric lights, and to give the company free use of the same for six months, on the condition that if the experiment shall prove successful, the company shall purchase the plant at a stipulated price.

A contract for a plant to burn crude petroleum oil at the pumping station of the Detroit Water-Works has been let to the National Supply Co., of Chicago, for $12,000. The plant is to be ready by July 1. The results of experiments with crude oil and natural gas, as compared with each other and with coal, were given in our issue of March 19, 1892. It is stated that the Tremont and Suffolk Mills, at Lowell, Mass., have determined that 166.4 gallons of oil equaled a ton of coal, the oil at 1.2 cts. per gallon costing $2 against $4.25 for a ton of coal.

An irrigation canal near Bakersfield, Cal., has recently been lined with brick and asphalt for 2,000 lin. ft. at a cost of 9 cts. per sq. ft. The canal is owned by the Kern County Land Co., and was lined by Curren & Lindgren under a contract. The work was done as an experiment. The lined perimeter of the canal measured 7 ft. The lining is described as a layer of brick upon which asphaltum was poured.

The California State Convention, called to consider the Nicaragua Canal, adopted a memorial to Congress, setting forth the commercial and military advantages of the canal to the Pacific coast and to the country at large, and also adopted resolutions favoring the holding of a National Nicaragua Canal Convention. The call for this convention to be held in St. Louis June 2, has been issued by Gov. Markham, as announced in our last issue.

The gun shops at Watervliet arsenal are at work on a number of 10-in. and 12-in. guns. A 180-ton overhead crane, driven by electricity, is nearly completed.

Plowing by electricity was tried at Kansas sorghum experimental station on March 30. The test developed the fact that the use of a rheostat with the motor would be essential to satisfactory results.

The Louisville and Jeffersonville bridge across the Ohio River, upon which work has been at a standstill for some time, will be carried to completion, according to newspaper reports. It will require about $800,000 to complete the structure, including the $260,000 due to the Phoenix Bridge Co., the contractors, for work already done, and arrangements have been practically completed to secure this amount. It is stated that work will be resumed at once and the bridge completed by November. It is 8,805 ft. long, including the viaduct approaches, and consists of one 210-ft., two 550-ft., one 553-ft. and two 341-ft. spans. The Phoenix Bridge Co., of Phoenixville, Pa., are the contractors.

An iron bridge 1,880 ft. long has just been completed at an expense of about $160,000 to carry the Wabash R. R. over the Wabash River, at Attica, Ind. The bridge consists of six through pin connected truss spans 108 ft., 151 ft., 153 ft., 153 ft., 149 ft. and 129 ft. long, respectively, and 12 plate girder spans, each 77 ft. 6 ins. long, and is supported on 17 masonry piers. The total weight of the iron work is 1,128 tons, and its cost was about $135,000. Work was begun last December, and was carried on under the direction of Supt. J. Murray, of the Pencoyd Bridge Co., of Pencoyd, Pa., which had the contract.

The Baltimore Belt R. R. tunnel at Baltimore, Md., has been completed for 2,700 ft. on Howard St. between Lombard and Franklin Sts. South from Lombard St. work is in progress upon the east wall, a shaft having been sunk at the corner of Liberty and Lombard Sts. The west wall has been finished from Lombard St. to Dover St., and as soon as the east wall is completed the arch will be built by removing the bed of the street, and a connection made with the open cut south of Camden St. There are now only five headings available for work, two each north and south from the Preston St. and the Madison St. shafts, and one north from the Franklin St. shaft.

A bridge over the Harlem ship canal at Kingsbridge to cost $400,000 has been authorized by the New York Legislature. The structure is intended to carry the Kingsbridge Road, or Broadway, over the ship canal, and will probably be built soon to avoid the cost of subaqueous foundation work which would be necessary if the work was delayed until the canal was completed.

The stand-pipe of the water-works at Temple, Tex., which fell Oct. 26, 1890 (see Engineering News, Nov. 1 1890) is to be replaced by one 15 ft. in diameter and 110 ft. high. The new pipe will be built by Ripley & Bronson, St. Louis. This firm furnished the material for the former pipe, Thomas & Gorman, Houston, being the contractors. The first pipe fell before it had been accepted from the contractors, the cause, at the time being reported as unknown.

A tunnel under the ship canal at Duluth, Minn., may result from the recent refusal of the Federal Government to allow the construction of a bridge because of its obstruction to navigation. It is stated that a proposition has been made to the Duluth City Councils by representatives of Eastern capitalists to build and operate such a tunnel upon receiving right of way and other priviledes. The tunnel will cost about $1,200,000 according to estimates made by Wm. Sooysmith some months ago.

A NEW PROCESS FOR DEALING WITH QUICKSAND.

From the beginning of engineering quicksand has been, when encountered, one of the most serious and uncontrollable obstacles to construction. But one mode of dealing with it with any success has yet been invented, the Poetsch-Sooysmith freezing process (Eng. News, Oct. 15, 1887, and many later issues). By this process a cold liquid is circulated through pipes with the effect of gradually freezing the quicksand solid for some distance around each pipe, the solid rings finally uniting into a single mass or wall.

FIG. 1. CAVE-IN ON SECTION 8, INTERCEPTING SEWER, PROVIDENCE, R. I.

This process has proved very useful in many cases, but from its very nature it requires a somewhat expensive refrigerating plant, a long-continued circulation of the freezing fluid, and a continuance of the circulation so long as it is desired to keep the material solid, if it is to be exposed for any considerable time.

The method to be described is the invention of Mr. Robert L. Harris, M. Am. Soc. C. E., and it has been recently tested experimentally on a sufficiently large scale to establish fully its practicability under proper conditions, in our judgment. It seems likely to prove a competitor of the freezing process in some fields, besides having useful application in cases where that process would not be suitable.

The gist of Mr. Harris' invention, on which he has taken out letters patent (No. 464,771, dated Dec. 8, 1891), is that, despite the very compact nature of confined quicksand and other fine material, it is always more or less permeable by water when of a nature to require special treatment to obtain foundations, or to drive shafts or tunnels through it. His theory was, therefore, that if two pipes were driven down into the same stratum, at a reasonable distance from each other, depending on the depth, and water was forced down one, it would seek for escape the line of least resistance, which would be through the quicksand, etc., up the other pipe, thus establishing a circulation by which a channel could be washed out between the two pipes, which would have no great tendency speedily to cave in because the hydrostatic pressure would maintain it for a time. By using more pipes, properly placed, more channels could be obtained, the material between them loosened and removed, and thus chambers could be practically formed. Presuming this theory to have been sustained in practice and channels or chambers to have been made, the plan was to substitute for the channel-making stream of water some cementing fluid, and, by a proper arrangement of valves, shut the outlet pipes as the cementing fluid reached them; and then apply pressure and cause the fluid not only to fill the chambers, but to permeate the adjacent materials. In this way a floor would be made between the pipes, and with successive withdrawals or depressions of pipes and a repetition of operations, it could be made of any desired thickness, or walls could be made. After these floors or walls had hardened underground the inclosed quicksand, in a case of sewer construction, for instance, could be easily excavated without serious infiltration, while the floor and walls would remain as a protection to the sewer and permit easy subsequent access to the structure for repairs.

This new method is somewhat in the line of a very interesting process devised by Mr. Harris and described in a paper before the American Society of Civil Engineers (Eng. News, March 14, 1891), entitled "A Caisson or Cofferdam without Timber or Iron in Its Construction." The novel mode of using cement therein described, which consisted in injecting cement grout through pipes into gravelly or sandy foundations was more especially adapted for coarse material, as rip-rap, gravel, etc., and acted by solidifying the entire mass in place on the principle of accretion. It did not attempt to produce any circulation of the solidifying fluid.

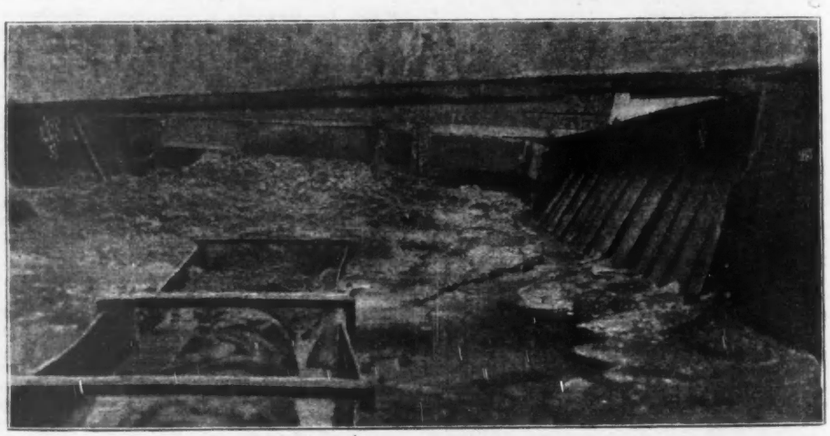


FIG. 2. MATERIAL AT BOTTOM OF SEWER TRENCH.

The circumstances under which this new plan was developed were as follows: For more than a year, as has been noticed in our news columns, great trouble has been experienced at Providence, R. I., in the construction of the new large intercepting sewer because of the quicksand which underlies a large area about that city. The trouble went so far that the contractors for the worst sections claimed that it was ruinous for them to proceed, and petitioned the branches of the City Government to release them from their contracts and cancel their bonds, which was done. The accompanying Figs. 1 and 2, which illustrate one of the worst points of difficulty, on Section 8, will show that they had good reason for these complaints and requests.

Upon Section 8 a pump was set at work upon a Saturday (January, 1891) on one side of the New York, Providence & Boston R. R. (which lies at the extreme right of Fig. 1, passing under the overhead bridge shown), its discharge being on the other or off side, in order to drain the water from the sewer trench. On the following Monday the neighboring area of forest of perhaps 150x75 ft., had sunk several feet in the extraordinary way shown in Fig. 1, the trunks of some of the trees being upward of 2 ft. in diameter, and 50,000 piled brick had been tumbled over on the ground, while from the discharge there had formed a few acres of quicksand one or two feet deep, where the previous week had been meadow.

What the material below was, which caused all this grief, is graphically shown in Fig. 2, which shows the condition of the trench near this locality about a month before (Dec. 1, 1890), and about 25 ft. below the surface. The trench for the large sewer had to be from 12 to 16 ft. in width, and from 20 to 30 ft. deep in quicksandy material saturated with water nearly from the surface. The borings indicated quicksand in various places aggregating in length over 4,000 ft.

This quicksand, when dry, is an impalpable powder. When saturated with water it is very compact and hard until disturbed. Under the pressure of a slight depth it becomes apparently almost solid, hammer strokes of 300 ft.-lbs., aided by a wash-pipe, causing 2-in. iron pipes to penetrate upon an average less than 0.1 in. per blow. Upon being agitated with water the quicksand becomes "alive" and runs like mush, as in Fig. 2. Its currents under pressure move glacier-like and are seemingly irresistible; 4-in. splined spruce sheeting in a 30-ft. trench snapped off at the bottom several planks at a time, the bottom of such sheeting being only 4 to 7 ft. below the confining wale piece or "ranger." Spruce struts were forced right into spruce rangers, and 8-in. sheeting was then used at such places. Nearly all the work done and trials made on this, as on other works, had been made by methods of sheeting, excavating, pumping out, reducing the water level, etc.

It appears almost self-evident from Figs. 1 and 2 that pumping out is not the best process for attacking such material as this, and this situation led Mr. Harris to form the opposite theory above outlined.

In considering the possibility of applying his conception of forcing in a solidifying liquid to practical work, Mr. Harris determined by office experiments that while quicksand in solution required hours to settle, yet when mixed with the cementing material all the solid matter was precipitated in a few minutes, leaving the water clear. He reasoned, that by producing a violent agitation in the main cavities just before the introduction of the solidifying fluid, a large amount of quicksand would be placed in suspension, and that the introduction of the foreign fluid would result in an intimate mixture, and thus precipitate immediately, so that there should result a floor composed of both substances in fairly uniform proportion.

Mr. Harris also devoted a large amount of time and experimenting to the determination of just what fluids would act best to solidify the material. It is obvious that this must depend largely on the nature

of the material. If sufficiently like a pure sand a pure cement grout might be best. If too fine or too muddy for that use, the cement might have to be "doctored" with sand or other substance, or plaster of Paris, or anything else which will in fact produce the desired solidification. The particular fluid used in the tests here described was a "doctored" cement grout.

Winter was at hand by the time the above described "working hypothesis" had been sufficiently developed to be ready for test, so that a trial of the entire system had to be postponed until about a month ago. The circulation feature had been proved by a test in the spring of 1891, with pipes driven 25 ft. deep at 4, 10 and 14 ft. distances. Early in March, 1892, preparations were made for a trial with 13 pipes; but the weather was still unfavorable, and

Fig. 3. Blocks of Quicksand Stone, Sawn Across to Show Stratification.

this and other disadvantages limited the trial to 4 pipes, driven in diamond shape 4 ft. apart to 17 ft. below the excavated surface, or to 1 ft. above the grade of the sewer, which was deemed enough for the purposes of the test. Channels were promptly obtained between the pipes in various directions and by simultaneously using the pipes a chamber was, as it were, swept out.

Freezing weather and other causes required the cavity to be maintained three days, to the possible detriment of the test; but the cementing fluid was then forced in through the pipes in order to produce a floor. This was done on March 15.

The result was investigated on the 2d inst., when the sewer excavation reached that point, and Fig. 4, reproduced from a photograph taken with the camera pointing downward from the top of the shaft, and hence rather puzzling at first, shows the "floor" which it was found had been produced between the four experimental pipes. We have added to the photograph two black and two white crosses to show the approximate position of the four pipes used for producing a floor. It will be seen that there was a tolerably solid and complete floor covering the entire quadrangle defined by the four pipes; and it goes without saying that had four additional surrounding quadrangles been defined by additional pipes adjacent to this mass, and the same process repeated before any excavation was made, the surrounding spaces would have been still more likely to have extended close up to the mass first formed, so as to have united themselves with it, so that the whole would have made a single floor. It would seem to be really more difficult to form a solid mass between four pipes only than to cover a considerable area attacked by many pipes, used alternately, so as to form a floor in checker-board fashion, the black squares first and then the white.

In regard to the details of the process in these particular tests, a 2-in. or other relatively large pipe was first driven down to the desired depth, and some of the material about its bottom washed out to leave a small cavity. A smaller pipe, carrying at its end suitable valves for closing the pipe against an upward current when the cementing fluid came to be injected, was then put down inside the larger pipe. When this inside pipe extended down below the outside one there was free passage for fluid either up or down. When the inner pipe was drawn up a little, however, all chance for the escape of fluid upward was cut off.

The details of the process are, of course, subject to considerable variation, and as the plant used for these tests was of a temporary and experimental nature, we need not describe it in more detail than this. The essential points, it is obvious, are that the pipes shall permit of a current either up or down, for washing out purposes, while at the same time it must be possible to close any one of them at the bottom when the solidifying fluid comes to be injected, so that the latter may be subjected to pressure and not escape again to the outer air. Care must also be taken that the pipes do not get frozen into the solid mass formed, so that they cannot be partially withdrawn to continue the operation.

Fig. 4. View of Floor, Looking Down Shaft.

The only plant required besides these pipes and the machinery for driving and manipulating them is a box to mix the grout or other cementing fluid in, and a pump of proper capacity to produce a considerable current in a 2-in. pipe and a moderate pressure when injecting the grout or other solidifying fluid. Fig. 5 will illustrate the method by which it is proposed to produce a floor between sheet piling, when a floor only is needed, and Fig. 6 will illustrate the method by which it is proposed to make a side wall when needed, by successive partial withdrawals of alternate pipes, using first one and then the other for the downward current, and the two adjacent pipes for the upward current.

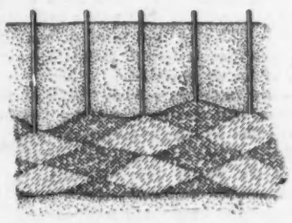


Fig. 6. Method of Producing Wall.

The experimental floor produced as shown in Fig. 4 consisted of a flat continuous stone-like slab, for some 6 ins. beneath which, and parallel thereto, were thin sheets of cemented material. At 10 ft. below the surface, to which point also the pipes had been drawn, there were formed additional flat blocks of artificial stone 3 to 6 ins. thick, reaching from pipe toward pipe. Fig. 3 shows some blocks of the solid material after it had been removed and sawn apart. We have seen and examined some large blocks of this quicksand stone, and can testify that it was very hard and solid; and, what was more, homogeneously solid, for a thickness of 6 ins. or more. There were marked streaks in it which varied considerably in hardness, but the distinction was rather between hard and very hard than between hard and soft.

All the strata were horizontal and distinctly showed the flow of the cementing material. The engineer in charge of the sewer, who many months before had said, "Give us a floor and we will do the rest," was present, and frankly expressed his gratification at the success of the trial.

We are disposed to think that this new process will prove to be a real addition to the resources of engineering. Of course, like everything else connected with troublesome foundations, much will depend upon judgment and "gumption," but in skillful hands the process seems to promise relief from the frightful uncertainties which otherwise attend attempts to work in, through or over quicksandy material. Mr. Harris claims further, with some reason, that the process is valuable not alone for use in quicksands, but in all kinds of loose sands and earthy materials, making it possible to build structures in fine or loose material, of the material itself, at any depth below the surface of the ground or its water level, as, for example, shore protections, jetties, foundations, shafts, tunnels, large or deep sewers, canal repairs, buildings, etc. The samples of the solidified and unsolidified quicksand which we have examined seem to justify this claim. It has been claimed that quicksand "killed" cement, but Mr. Harris' theory was that it was not the quicksand but the motion of the quicksand which killed the cement, and that when confined together they would form a solid mass, as with other sand. The result certainly appears to justify this new theory. We shall await the results of more extended tests of this new process with much interest.

APPARATUS FOR DETERMINING THE WEAR ON PAVING MATERIALS.

An apparatus is in use at the German Government testing station at Charlottenburg, Berlin, employed to determine the wear on paving and flooring materials, which as described in the "Zeitschrift fuer Transportwesen und Strassenbau," consists in substance of a horizontal cast iron disk of about 31 ins. diameter, which, driven by a bevel gear, makes 22 revolutions per minute. The revolutions are registered by an apparatus in connection with it, which strikes a gong at the completion of each 22nd. revolution. Then ¾ oz. of Naxos powdered pumice is spread on the disk immediately in front of the testing piece in such a way that the whole amount

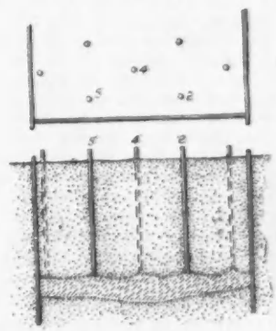


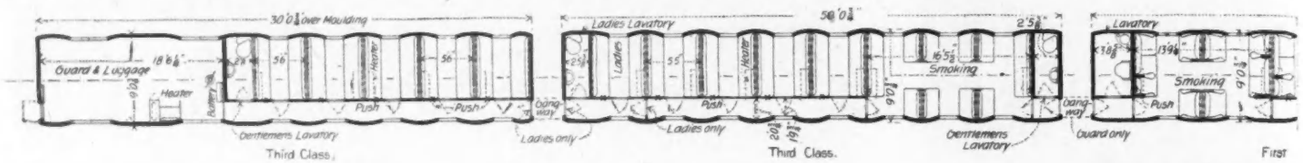
Fig. 5. Method of Producing Floor.

of powder must pass the sample. This is pressed against the disk by a one-armed lever weighted with 66 lbs., so that a smooth surface of nearly 8 sq. ins. is exposed to the grinding process. After 110 revolutions are completed, motion is suspended and the previously weighed testing piece, after being carefully dusted with a brush, is weighed over again. This process is repeated four times. Then the sum of the different losses by wear, divided by the specific weight of the respective material, will give the amount of wear in cubic centimeters.

The screw steamer "New Hampshire," built by the Harlan & Hollingsworth Co. for the Providence & Stonington Steamship Co., made 18¼ miles per hour in her trial trip on April 21. She is a duplicate of the "Maine," recently finished by the same builders. These vessels have been described in Engineering News, and will both be in service this summer.

CORRIDOR CARS FOR THE GREAT WESTERN RAILWAY, ENGLAND.

In our issue of March 26 we described a new train of corridor cars which has recently been put in service by the Great Western Railway, of England. The train runs between London and Birkenhead (opposite Liverpool), a distance of 220 miles, making few stops, and we give herewith a plan of the complete train, for which we are indebted to Mr. Wm. Dean, Locomotive Superintendent of the road. The train consists of three passenger cars, for first, second and third class passengers respectively; a combination baggage and third class car at one end, and a baggage car at the other end. The baggage car is 40 ft. long and 8 ft. 0¾ in. wide over the body, and has a middle compartment for the guard or conductor, with a seat placed in a projection in each side of the car so that the conductor can keep a look out along the train. The other cars are 50 ft. 0¾ in. long, and 9 ft. 0¾ in.



CORRIDOR CAR TRAIN.

wide over the widest parts of the sides, which bulge out between the doors as shown. There are windows opposite each seat, but only the doors are marked on the plan.

The passenger cars are divided into compartments, with a corridor 2 ft. wide along one side, except at the smoking rooms, which are the full width of the car. The corridors of the cars are connected by flexible gangways, which are for the use of the guard only. The cars are heated by steam from the locomotive, a heater being placed in each compartment, as shown by dotted lines, and the supply of steam can be regulated by the guard. In each compartment is an electric push button for sounding a bell on an annunciator in the guard's compartment. This signal is only to call the guard in case of emergency. The current is supplied by a battery in the combination car. The cars are lighted by compressed oil gas, with central lamps in the raised monitor roofs, in the same manner as the cars of the company's West of England express trains (Eng. News, Feb. 28, 1891). Each of the three passenger cars has a smoking compartment, a women's compartment, and separate lavatories for men and women. The second-class car has a baggage compartment. The combination car has a lavatory but no smoking compartment. The general arrangement of the cars is similar to that of the Mann boudoir cars, brought out in this country some years ago, and introduced to some extent in Europe. Compartment palace cars have also been introduced within the last year or two on some of the New York and Chicago limited expresses. An English third-class saloon car on the corridor plan was described in our issue of Feb. 7, 1891, but one objection to this arrangement is that the interior partition must darken the compartments to some extent, especially in gloomy weather.

AMERICAN TYPE OF FREIGHT CARS FOR FOREIGN RAILWAYS.

For about two years a movement has been in progress in England to introduce the American type of freight car, with its flexible wheel base and large carrying capacity, to replace the old-fashioned short cars on two or three rigid axles. This movement has been headed by Mr. M. R. Jefferds, who represents a company manufacturing a special form of car of the American type, and in the face of strong conservatism and opposition he has succeeded in getting these cars tried on several roads. The arguments which Mr. Jefferds advances apply to the American type of car generally, except in so far as he claims superiority for the special mode of construction in his own cars. English railway men have claimed that short passenger and freight cars are more suitable for their lines, the former to allow of the running of through cars to several points without adding too heavily to the dead load of trains, and the latter on account of the many small individual freight shipments. In spite of this, however, the long passenger cars on four-wheel or six-wheel trucks are now very extensively used, and are much more comfortable to ride in and more easy on the track than the short cars with four or six wheels and a rigid wheel base. In freight service the advance toward the introduction of the long cars on trucks or "bogies" has been very much less, although their advantages are evident, particularly for such bulk freight as coal, ore, ballast, etc.

Short four-wheel and six-wheel coal cars, with a capacity of 7,000 to 8,000 lbs., and having a rigid wheel base, are still in use in this country on some of the railways having a large coal traffic. The Central R. R. of New Jersey and the Philadelphia & Reading R. R. have decided to abandon these short cars, as they are not economical in service, and are severe on the track, while when the speed of a long train of these short, light cars is suddenly checked, the cars in the middle of the train often jump the track owing to the pressure, and serious wrecks have been caused in this way. On English freight trains this squeeze pressure is not experienced to such an extent, the cars having generally very slack couplings and many having spring buffers.

In our issue of June 6, 1891, we stated that the Tubular Frame Wagon Co., of London, of which Mr. M. R. Jefferds is general manager, had secured works at Barrow, England, for the construction of its cars, and since then a number of cars have been built for English and foreign railways. The special feature of these cars is in the frames, which are composed of tubes, as described more fully later. About 10,000 cars of this kind are said to have been built in this country, the patents (Goodfellow and Cushman's) being owned here by the Iron Car Equipment Co., of New York. The Philadelphia & Reading R. R. has about 1,500 tubular frame cars, some of them plain gondolas for general work, and the others provided with a drop bottom for coal traffic. These cars are reported to us as rendering good service, but no separate account of the cost of running and repairs, to enable a comparison to be made of their cost as compared with the ordinary cars. The Chesapeake & Ohio Ry. has about 100 tubular frame, hopper bottom coal cars, with a capacity of 30 tons, and an average weight of 25,000 lbs., as against 26,000 lbs. for a wooden car of the same class. The shop people estimate, however, that it will cost 20% more to maintain the tubular frame than it does to maintain the wooden frame car of the same class.

The tubular frame cars have trucks of the diamond pattern, now generally used for freight cars, but the mistake has been frequently made, especially in England, of saying that these trucks are the standard of the Master Car Builders' Association, of America. At the convention of that association in 1884, the diamond frame was recommended as one of the details that should be embodied in a standard freight car truck, and a committee was appointed to prepare a design in accordance with the recommendations, including a wheel base of 5 ft., diamond frame, channel bar transoms, and adaptability to either swing or rigid bolster. This committee reported in 1885 and 1886, and presented drawings of the diamond truck, but the work of the committee never resulted in the adoption of any standard truck. There are many railway men who do not approve of the diamond frame truck, claiming, among other things, that it is very severe on the track owing to the arrangement of the springs.

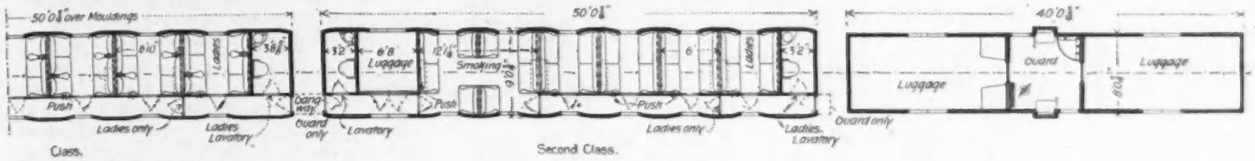
Mr. Jefferds writes us that channel iron sills have been found too rigid in England, in other European countries and in the Argentine Republic, and that some of the best English engineers, including some who are consulting engineers of foreign railways, have stopped making plans for channel iron frames, and have gone back to timber sills, as they are more elastic and, therefore, not as hard on the rails and track. Mr. Jefferds complains that the English workmen are not as efficient as American workmen, but it scarcely seems probable that the difference is so great as stated in the quotation given below. Referring to the use of his cars in Europe he says:

> The Belgian Government has had our tube-frame cars for nearly three years, and runs them in the same service with channel-frame flat cars, having square frame bogie trucks, and readily admits the superiority of our construction in the greater ease with which the cars are moved, and carry their loads, as also their immunity from repairs, our cars having required no repairs, while theirs are continually getting out of repair. We are building cars here now, but it costs us about 17½% more to build here than it does in America, the difference is principally in labor, the workmen in England not doing more than a third as much work as those in America.

Some of the low-side open cars with tubular frames, for English railways, weigh 8 gross tons and have a capacity of 30 gross tons, while high-side cars weigh 10 tons and have a capacity of 30 tons. We have received from Mr. Jefferds the following communication on "light weight, high capacity rolling stock":

> Railways have within the past 60 years largely superseded other methods of transportation, and have reached such a point of perfection that in the United States the products of industry are in some cases transported between the producer and consumer at a charge of only half a cent per ton per mile, leaving a fair profit to the carrier, and yet it is not thought by many practical railway men that the minimum cost of handling traffic has been reached. Improvements are presenting themselves on every hand and those who have taken advantage of them show the best results. The two-wheel cart was superseded by a four-wheel vehicle now called a wagon, but which, for many years, was not adopted on account of its insusceptibility of being turned round, resulting from its rigidity, or of being moved in any direction without the expenditure of great power. From six to eight yoke of oxen were required to move this vehicle loaded, until the "king-bolt" was tried on the forward axle, when it was found that one yoke of oxen with the king-bolt improvement could move a far greater load a long distance than eight yoke of oxen could move the same vehicle without it. This improvement stands good to-day as far as street vehicles are concerned. It was found at an early period that the reduction of friction was a great factor in cheapening transportation, therefore highways were superseded by tramways and tramways by railways for the transportation of heavy traffic.
>
> In using tramways it became apparent that some other motive power than that supplied by horseflesh would be necessary for quick and cheap transportation. Mr. Geo. Stephenson, after much opposition and ridicule, succeeded in harnessing his iron horse, and with fuel and water instead of hay and oats generated a motive power, the limits of which are not yet known. He built cars of the four-wheel type with rigidly parallel axles, similar to those first built for highways, thinking that as they had no corners to turn they would need no "king-bolt," or swiveling axle in front, especially if the railways were to be built, as recommended, on as straight lines as possible. These cars answered the purpose and multiplied rapidly without question as to their economical nature, the all absorbing topic being the development of the iron horse and not the car. All countries copied after the English master, and many of them, like England herself, still cling to the original type that was first used experimentally and then adopted without any regard to economy or scientific principle. The same objection to the use of the rigid four-wheel car that stood good for highways then stands equally good for railways now.
>
> These cars were the type of rolling stock first used in the United States, but owing to heavy grades and sharp curves they were discarded at the suggestion of Mr. George Stephenson himself, and replaced with vehicles having a leading and trailing truck or bogie with four wheels each, upon the center of each of which the body of the vehicle rests, permitting the trucks, each independent of the other, to follow the

sinuous direction of the track without disturbing the equilibrium of the body it is attached to. This appliance is called in England a bogie truck, the name being taken from a vehicle that could be turned round in its own length formerly in use at Newcastle-on-Tyne. (Mr. John B. Jervis, the eminent American engineer, was the inventor of the "bogie" truck for locomotives, as shown in Engineering News, Feb. 26, 1887.—Ed.) The first bogie trucks used in America were built with square frames and were the source of much expense and annoyance both in maintenance and in keeping them on the track. The frames were rigid, and if three of the wheels were on a level and the fourth over a depression one of the wheels would hang, therefore equal bearings could not be maintained without seriously wrenching the frame and shearing the heads of rivets that held it together. The same fault has been found with all four-wheel bogie trucks, having rigid frames riveted together. To Mr. Ross Winans must be given the credit of inventing the frame known as the "diamond truck" that has been in use over 40 years and never found wanting, and is now in use on nine-



GREAT WESTERN RAILWAY, ENGLAND.

teen-twentieths of the freight rolling stock in the United States. This truck is pliable enough to permit of each wheel resting on a different level like a three-legged stool, giving an equal bearing on each journal. This truck is strongly recommended as it costs but little for repairs.

Little or no improvement has been made in freight rolling stock in the older countries, while in America the improvement has been great. The first improvement was the adoption of the swiveling bogie truck, with the body of the vehicle resting upon a 12-in. bearing plate with a king bolt in its center, by which means the vehicle could be moved with greater ease and turned round in its own length. The freight cars in America of 30 years ago were not unlike in appearance to those in use to-day, but the difference in construction is very marked. The old bogie cars were made to carry 10 to 12 tons upon a tare weight of 9 to 11 tons, or 82½ lbs. of tare weight to every 100 lbs. of paying load. The best type of freight cars in use to-day is that having diamond frame trucks upon which rest bodies made with four sills, each consisting of two wrought iron tubes 2⅞ in. diameter, placed one above the other, about 7 in. c. to c., and held in place by malleable iron clamps, which are interchangeable. The end sills for the corner buffing are made of channel iron with diagonal bracing to distribute equally the force of an impact to all of the sills, and those for center buffing and draft have end sills built up of wrought iron bars and malleable iron fastenings, so strongly trussed that they will resist the most severe impact. In the construction of this car, the whole strength of the materials used is preserved; no portion is drilled, cut or weakened; and there are no rivets to be cut off by vibration. The tare weight is only about one-third of its carrying capacity; the wheels are centered, balanced and turned to a true circumference on the tread; the springs are of the compound graduated pattern, which permits of the body of the car riding as easily empty as loaded, and while the frames, owing to their tubular sills, have a remarkable stiffness for resisting impact longitudinally, their elasticity transversely is sufficient to carry with ease and safety loads far exceeding their rated capacity and far greater loads than it is possible to carry on the same weight of material in any other than the tubular form of frame.

The saving due to the lessening of dead weight by the use of the tubular frame is more than equal to the mileage on an ordinary car; the annual saving due to increased load is more than equal to the first cost of the car; the length of train being shortened one-third to one-half, the engine power is reduced in proportion; a less number of cars being required, the saving in dead weight may be utilized by a corresponding increase in paying load, and in case of wreck, the salvage on the tube frame car greatly exceeds that of any type of car yet offered to the public.

Although the invention of this type of car is of quite recent date, there are over 10,000 of them running upon railways in the United States, 350 in Chile and Peru, 130 in New South Wales, while in Tasmania, Brazil, the Argentine Republic, Cape Colony, Cuba, Mexico, Italy, Spain, Belgium, France, Ireland and England they are being used with astonishing results. The most recent accounts are from the Nitrate Railway of Chile, where, with 270 of these cars, they have reduced the working expenses from 43% of the gross receipts to 26%, and the Arauco Company, having 50 of them, reports a reduction of 20% in its working expenses during the past six months, although during that time they had only four months' use of the tubular cars.

The intrinsic character of these cars has ceased to be a matter of experiment. They will bear up and carry with safety a load that would break in two the best wooden car ever built; they will swing with perfect ease round curves that would stop the ordinary wagon; they are never "down," in all weathers they are the same, unaffected by sun, rain or frost; they do not spend one-half or one-third of their time in the shops undergoing repairs; they have been tested in every way; a train of wooden cars has been driven into one of them at high speed, and although its brakes were hard down, it received the shock and came out uninjured, while the wooden car that was run into it was completely wrecked. They have been upside down off the track and set to work again without requiring any new material for their repair. Four of them were in a recent wreck, where a whole train left the rails, and nearly every vehicle badly smashed, yet out of the four, owing to the interchangeability of parts, three were built up again alongside of the wreck, while some of the other cars were a total loss, and the others had to be taken to the shops for repairs.

It was upon 112 of these cars that the Brighton Beach Hotel, weighing over 6,000 tons, was moved back 576 ft. from the beach at Coney Island four years ago (Engineering News, April 7, 1888) and the same cars have been in service, carrying their heavy loads, ever since, without requiring a penny for repairs except for repainting.

A GREAT EXPERIMENT IN ELECTRICAL ENGINEERING.

The completion of the 10,000-HP. dynamo which Mr. Z. de Ferranti proposed to build at the Deptford station of the London Electric Supply Co., bids fair to be postponed to some future generation. The present equipment of the Deptford station includes four Corliss engines aggregating 4,500 HP., and with this power some 42,000 lamps are supplied. The Chairman of the company said, at the annual meeting, that, to tell the truth, the proposed 10,000-HP. dynamo to be driven by a single steam engine is years ahead of its time. Such a machine would supply at least 250,000 lamps, for it is to be remembered that the maximum number of lamps in service at any one time is always much less than the total number on the circuit. Central stations supplying such a great number of lamps are, so far as we know, not yet in existence. The London Electric Supply Co. can not yet muster a fifth of that number. Moreover, the experience of electric lighting companies the world over is against very large units. About 1,000 I. HP. seems the best for large, and 500 I. HP. for moderate installations. The smaller the units, the less is the delay and trouble caused by the breakdown of an engine or dynamo; and in operating an electric lighting plant reliability must take precedence even of economy. This means, doubtless, that no more work will be done on the great dynamo, which was to have an armature 40 ft. in diameter and weighing 230 tons. In this connection it is of interest to note that Mr. Ferranti's place as Chief Engineer has been taken by Mr. P. W. D'Alton, the principal assistant in the construction of the Deptford Station.

While the 10,000-HP. dynamo project is in abeyance, much better success has attended Mr. Ferranti's scheme for transmitting electricity at the high potential of 10,000 volts. Two 750-HP. engines drive two great dynamos generating a 2,500-volt current, which is raised to 10,000 volts by a transformer, for transmission to the distributing station in London. The two other engines and dynamos in the Deptford Station, each of 1,500 HP., were run for some time generating a 5,000-volt current. About a year ago it was attempted to operate them at 10,000 volts; and, although there were many difficulties and derangements, fair success was finally attained, and for four months past breakdowns have been of rare occurrence.

The officers of the company seem hopeful with regard to its future prospects, though it must be confessed that the present status is hardly encouraging. The total capital expended to date amounts about $3,875,000. The receipts during the past year were $75,466, and the running expenses were $109,125, or about $35,000 in excess of the receipts, with nothing whatever for capital invested. American electric lighting companies are somewhat prone to complain of small returns for their expenditures; but we feel safe in saying that none of them can rival this showing. Mr. Ferranti has accomplished some wonderful feats in building electrical machinery and in the transmission of electricity at high voltages; but, as often happens, such feats were not immediately profitable to those directly interested.

SIX LEADING CRUISERS.

We abstract from a table in the New York "Times," which seems to have been carefully prepared, the following comparative information in regard to six leading modern cruisers, two of them American, and the others British, French, Spanish and Russian. None of these ships has as yet been commissioned. The Russian "Ruric" is now building at St. Petersburg. She will have a complete belt of steel and an armored deck. Her reported endurance of 20,000 knots is quite beyond precedent, as was the "Pirate's" 10,000 when she was designed.

The French ship is now completing her machinery trials, and the Spanish is still building at Cadiz. Both are designed for very great coal endurance, though it is not stated for the French ship.

The British cruiser "Crescent" was launched at Portsmouth March 31, and inspired the British service journals to pronounce her the finest cruiser afloat. Taking as texts her armament and protection, these journals even go so far as to compare her favorably with the "Pirate," which is now building for the U. S. Navy at Cramp's yards, and which Secretary Tracy has pronounced "absolutely without parallel among the war ships of the world." It is hard to see on just what grounds this is done, as

	Russia. "Ruric."	Spain. "Carlos V."	U. S. "New York."
Length	426 ft.	364 ft.	380 ft.
Breadth	67 ft.	65 ft.	64 ft. 5 in.
Draft	27 ft.	22 ft.	23 ft. 3 in.
Displacement	11,000	9,235	8,150
I. HP.	15,000	15,000	16,500
Speed—nat.			
draft	18	19	20
Endurance at 10 knots	20,000	12,000	6,750
Armor—max.	10-in.	6-in.	6-in.
Armament.	4 8-in. B. L. 16 6-in. B. L. 14 4.7-in. B. L. ..... 18 machine.	2 11-in. B. L. 10 5.5-in. B. L. 8 6-pdr. B. L. ..... 6 machine.	6 8-in. B. L. 12 4-in. B. L. 8 6-pdr. 4 1-pdr. 4 machine.

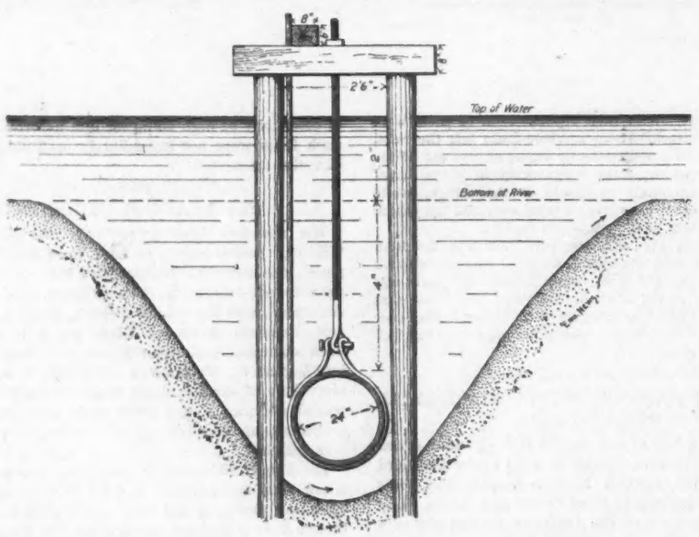
	Gt. Britain. "Crescent."	U. S. "Pirate."	France. "Dupuy de Lome."
Length	360 ft.	412 ft.	374 ft.
Breadth	60 ft.	58 ft.	52 ft.
Draft	24 ft.	24 ft.	23 5 ft.
Displacement	7,700	7,470	6,297
I. HP.	9,000	21,000	14,000
Speed — nat. draft	19.5	21	17.5
Endurance at 10 knots	10,000	10,000	.....
Armor—max.	6-in.	4-in.	4-in.
Armament.	1 9.2-in. B. L. 12 6-in. B. L. 16 6-pdr. 3 3 pdr. 2 machine.	4 6-in. B. L. 12 4 in. B. L. 16 6-pdr. 8 1-pdr. 4 machine.	2 7.4-in. B. L. 6 6.3-in. B. L. 2 9-pdr. R. L. 4 3-pdr 8 machine.

her speed and indicated horse power are much lower, although her armor and armament are much heavier. In a battle ship the last two would be decisive

advantages, but as cruisers are intended primarily as commerce destroyers, and not to fight except where they have the advantage or cannot help themselves, it would appear as if the "Crescent" were the poorest ship in the six, since the other five are all either faster or more powerful. Coal endurance, of course, is a matter of small importance to a British ship, since Great Britain has coal stations at frequent intervals all over the world. It would appear also as if either the speed or the horse power of the "Crescent" must be relatively in error.

LOWERING SUBMERGED WATER PIPE ACROSS THE PLATTE RIVER AT DENVER, COLO.

In our issue of March 19, 1892, we described and illustrated a proposed new method for laying submerged pipe of large size and referred to some of the methods actually used in laying such pipe. Since the article named was written we have received from C. P. Allen, Chief Engineer of the Citizens' Water Co., Denver, Colo., a description, with an illustration, of a novel method employed by him in laying a 24-in. main at Denver, and in sinking a trench for the pipe. Mr. Allen describes the process as follows in a letter to this journal:



METHOD OF LAYING CAST-IRON WATER MAIN AT DENVER, COLO.

I have been very much interested in Mr. G. W. Pierson's description of pipe laying across the Oskaloosa River, Iowa (at Oskaloosa, Ia.; see Engineering News, Jan. 23, 1892) and have thought that an account of somewhat similar work might be of interest to your readers. The beds of our streams have a depth of sand and gravel of from 10 to 40 ft., which usually moves very little in flood water, except about some obstruction, so pipe laying is probably not as difficult a matter as in other streams. The following method was employed in laying a 24-in. main across the Platte River at the foot of Sixteenth St., Denver, Colo., for this company:

At the point where this main crosses, the river has a grade of about 15 ft. to the mile, and was carrying at the time some 234 cu. ft. of water per second, the channel being 180 ft. in width. Piles, placed 12 ft. from center to center, were driven in two rows 30 ins. apart across the bed of the stream, as shown in the accompanying illustration. To these were nailed temporary supports, their upper surface 3 ins. above the water, to enable us to make joints. Upon these supports was then placed pipe of sufficient length to extend into the river bank at each end of the crossing; 45-degree bends, with one length of pipe, were attached at each shore end, the bends being pointed upward, in order that the open ends might be kept above water when pipe was lowered. All joints were then heavily leaded and carefully caulked.

Next, 6x8-in. cross timbers, resting on top of piling, were placed in position over the pipe. For lowering the pipe to place, a long screw, 1½ ins. in diameter passed through the center of each cross-timber, and was connected to the pipe by a ¾-in. round iron band so arranged as to be easily detached by driving out a key after the pipe was in position. The temporary supports were then removed, men with wrenches were placed at each screw, and the entire length of pipe was lowered at a uniform rate.

When the pipe was within a few inches of river bottom, a board dam was built the full width of the stream, and extending from a few inches above the surface to the river bed, the top of boards being nailed to a 6 x 8-in. timber running parallel with the pipe, against which their lower ends rested. This arrangement forced all water to pass under the pipe. Lowering was then renewed, and carried on with slight interruptions caused by encountering hard gravel beds. Two methods were used in removing these: Loosening with long iron bars, and driving boards against the bottom of the river at low points along the dam, thus forcing water beneath the pipe at places where these hard strata occurred, the increased velocity being sufficient to cut them away. The pipe was lowered until its upper side was 4 ft. below the natural bed of the river. The board dam was then removed and the piling cut off level with the top of pipe by means of a cross-cut saw rigged in a frame similar to a wagonmaker's whip saw, but on a larger scale. The object of cutting the piles below the river bed was to prevent their catching drift of any kind, which would have tendency to set up a digging or scouring in the gravel about the pipe. In two or three days the space above the main had filled and the river bed had assumed its original grade.

The pipe used at this crossing weighs 3,200 lbs. per length and is under a head of 276 ft. Elevations were taken on each length of pipe before lowering, the whole being tested from time to time as the work progressed, but no movement of the joints was discoverable. The lowering screws were left in place until the gravel had settled back, in order to prevent any movement of the pipe when they were detached. After the shore ends were connected, excavations in each bank of the river were filled with smelter slag to prevent floods from disturbing the pipe.

AUTOMATIC SPRINKLERS.

The following is an abstract of a special circular on automatic sprinklers for fire protection which has recently been issued by the Boston Manufacturers' Mutual Fire Insurance Co., which gives very interesting particulars of this system of protection:

Automatic sprinklers were placed over the whole of three cotton mills, except the weaving, by Col. T. J. Borden, of Fall River, in 1874. The system was adopted in a few other mills, without any urgent suggestion from the underwriters, in subsequent years to 1877, inclusive. In 1878, the officers of this company became satisfied that it would become the most efficient safeguard against the increasing hazard of our risks, and should be steadily presented for general adoption. The most thorough tests and experiments were then made upon automatic sprinklers by C. J. H. Woodbury, C. E., now one of the vice-presidents of this company, under whose supervision most of this report has been prepared. The result of this work has been largely in suggesting improvements upon automatic sprinklers, and preventing the acceptance of many varieties containing serious defects.

The true measure of the value of automatic sprinklers as a protection against fire is best shown by the experience of this company for 15 years on property where this company has shared in the insurance; dividing fires into two classes, the one being the fires in which a properly installed equipment of automatic sprinklers was called into service over the fire where it started; the other division being the remainder of the fires; including many where automatic sprinklers did good service in retarding the further extension of fires which had burned to rooms equipped with such apparatus.

A large number of fires in the second class is due to the fact that the introduction of automatic sprinklers was very slow until their usefulness was fully established by experience, and until the cost was reduced by the competition which was promoted by us to the utmost, the great expense of such apparatus having at first retarded its introduction. There are many places like foundries and other works where automatic sprinklers may not be required. The second division also includes the great number of fires extinguished with little or no loss by that most valuable of all fire apparatus, buckets of water in judicious hands. If the fires put out by buckets of water were separately classed, the advantage of automatic sprinklers would become very much more conspicuous in the small ratio of loss.

Experience Jan. 1, 1877 to Jan. 1, 1892.

	Fires	Claims.	Losses.	Aver. fire.	Average claim.
Automatic sprinklers.	406	266	$247,673	$610	$1,202
Other apparatus.....	1,196	501	$8,720,437	$7,291	$17,406

The introduction of automatic sprinklers has reduced the average loss per fire, within the experience of this company where they were in service, to 8.3 per cent., and the average loss per claim to 6.9 per cent. of what it is apparent that such fires and claims might have been under the previous conditions of protective apparatus. But any classification must be made on arbitrary divisions and the proportions of each class might be differently placed by another; yet in any case the result would show a very great reduction of fire loss.

Automatic sprinklers have their limitations and may not stop a fire which starts elsewhere and burns to the room where they are installed, although there have been many instances where they performed valuable service under such conditions. They are not suited to the protection of large open spaces, or to deep piles of combustible material. Manufacturing processes generating corrosive vapors, or producing adhesive deposits upon automatic sprinklers, impair their efficiency.

From the very first there have been apprehensions of leakage from automatic sprinklers; it is true that there have been serious mishaps by leakage from sprinklers which were not approved, because of the apparent inability of such sprinklers to resist continued pressure and the impact of water hammer. A few years ago, a census was taken of all accidents to approved automatic sprinklers on property insured by this company, and it was found that for five years there had been 58 instances of leakage from the inability of the sprinkler to resist water pressure, but it should be stated that none of these sprinklers are now on the market. There were 317 instances of leakage in which the construction of the sprinkler bore no part whatsoever, being caused by breaking of belts, or pieces flying from machinery and other miscellaneous causes. The damage from all these accidents averaged $1.63 per sprinkler plant per year. Many accidents to sprinkler systems could be prevented by placing guards like staples made of 3-8-in. iron around the sprinklers, wherever they are in reach, as in many attic rooms.

Automatic sprinklers should have two sources of water supply, from one of which the water should rest on the sprinklers all the time; if one supply should be furnished by an elevated tank protected against freezing, the bottom of the tank should be at least 12 ft. above the highest sprinkler. In any case, the tank should not have any outlet except for the overflow and the sprinkler supply pipe. The use of an outlet near the top for supplying sinks is not recommended, because sediments will deposit in the tank. For a like reason water should not be drawn off from the pipes unless absolutely necessary, because changing the water causes corrosion and increases the deposition of sediment in the pipes. The piping to a sprinkler system should be as simple as possible, with check valves in the mains or the risers opening toward the sprinklers giving the system the advantage of the source of supply which has the greater pressure.

There should be the least possible number of valves, and these only at the sources of supply to the system. All valves should have an indicator or telltale, clearly showing whether they are open or shut. Indicator valves are made by all the leading manufacturers. Among whom are the Chapman Manufacturing Co., Boston; Daniel Kennedy, New York; Walworth Manufacturing Co., Boston; R. D. Wood & Co., Philadelphia, and Ferrell Manufacturing Co., New York. In some instances these devices can be applied to valves already in service if the hand wheel of the valve can be removed.

Valve posts should be placed over the gates in underground mains, which in like manner indicate whether the valves are open or shut. They can be operated by a wrench or hand wheel applied to the top of the valve post, and do not require a long wrench.

The following is the standard schedule of sizes of pipe computed as nearly as possible upon the uniform loss of head by friction throughout the system, and they have proved to give an effectual service up to this time.

Diam. of pipe.	No. of sprinklers.	Diam. of pipe.	No. of sprinklers.
¾	1	2	18
1	3	2½	28
1¼	6	3	46
1½	10	3½	70
		4	95

Tests now contemplated may possibly lead to some slight changes in these proportions in the installation of new plants, but so far as experience to this date warrants these proportions, they have been justified. Covered machines of a hazardous nature, as rag dusters and cotton or wool dryers, should have one or more automatic sprinklers on the inside of the cover.

The top of elevator wells should be protected either by one mammoth sprinkler, with an opening 1 in. in diameter, such as are made by the Hill and the Walworth companies, or at least two sprinklers of the ordinary size with a board placed as a screen between them so that one sprinkler cannot be chilled by the water issuing from the first one opening. The following areas have been agreed upon by the Associated Factory Mutual companies as the standard area to be protected by one sprinkler. The first part of the table is for standard mill construction, with one row of automatic sprinklers in each bay, placed midway between beams. The second part is for open joisted ceilings, in which sprinklers should preferably be placed directly under a joist.

	With Water Pressure at Highest Sprinkler. Over 20 lbs. per sq. in. Med. haz. Ft. apart	Spec. haz. Ft. apart.	Under 20 lbs or by tank. Med. haz. Ft. apart.	Spec. haz. Ft. apart.
For Standard Mill Construction.				
In 12 ft. bays	8	7	7	6
" 11 ft. "	9	8	8	7
" 10 ft. "	10	9	9	8
" 9 ft. "	11	10	10	9
" 8 ft. "	12	11	11	10
" 7 ft. "	12	11	11	10
For Open Joisted Ceilings.				
At right angles to joists.....	8	7⅛	7⅛	6¼
Parallel with joists.....	10	9	9	8

The terms "medium hazard" and "special hazard" relate to the contents or occupancy of each room. Specially hazardous places are such as picker rooms, planing or sawing departments of wood working establishments, painting or varnishing rooms, etc. In all cases the distance from wall to first sprinkler should not exceed half the distance between sprinklers in same direction. The splash plates of sprinklers should be at least 3 ins. below joist or ceiling. In buildings having ceilings similar to standard mill construction, but with beams not exceeding 6 ft. apart, c. to c., a row of sprinklers under alternate beams is admissible, placed under centers of beams instead of midway between beams. Spaces directly over storage bins or racks, or immediately surrounding stairways, elevators or large belt openings, should be considered under the rules for "special hazard," and deviation from the rectangular lay out made, and extra sprinklers inserted, if necessary to secure an effective distribution.

There are few buildings insured by this company where wood cornices will be exposed by fires occurring in other buildings, but for such places automatic sprinklers do not serve the best purpose, as they distribute water over a circular area. In such places the cornice sprinkler, invented by J. P. Swan, distributes water in a fan-shape, concentrating the whole along the line of the cornice to be protected.

The following automatic sprinklers are accepted on an equal basis:

Name.	Manufacturer.
Grinnell	Prov. Steam & Gas Pipe Co., Providence, R. I.
Hill	John Hill, Columbus, Ga.
Neracher	Neracher Sprinkler Co., Warren, O.
Clapp	Chicago Sprinkler Co., Chicago, Ill.
Walworth	Walworth Mfg. Co., Boston, Mass.
Kane	Kane Fire Extinguishing Co., Philadelphia, Pa.
Manuf's.	Mfrs. Automatic Sprinkler Co., Syracuse, N. Y.

The "sealed or water joint" sprinklers of the Parmelee and Burritt types, which were well approved in their day and have been justified in their service, are no longer in the market; they have nearly all been removed to give place to the more sensitive types of sprinklers named in the present list.

The fusible solder used in automatic sprinklers has other and useful purposes, particularly in its application, by the Providence Steam & Gas Pipe Co., to fire doors which can be shut and opened at will in the usual manner and without interference to the fusible links which cause the door to close when exposed to a temperature of 160 degrees. This should not remit the enforcement of the usual rule to close fire doors at night, noon, and whenever an open passage is not required. (The automatic fire door referred to was illustrated in Engineering News, Dec. 14, 1889.—Ed.)

NEW TERMINAL STATION AT CHICAGO FOR THE ILLINOIS CENTRAL R. R.

Plans have been prepared for a new terminal passenger station for the Illinois Central R. R. at Chicago, to replace the old station which was destroyed in the great fire of 1871 and has never been rebuilt. The site will be a little farther from the center of the city, being on the lake front at the south end of Lake Front Park, and near Twelfth St. and Park Row. It will be a terminal station for main line trains, but suburban trains will run through as far as Randolph St., where a new station for suburban traffic will be built eventually. The location and general arrangement of the main terminal station have been settled by Mr. J. F. Wallace, Chief Engineer, and Mr. Bradford L. Gilbert, of New York, is architect for the building. Our illustration represents the up-town or north face of the building, showing the openings through which the suburban tracks pass to the trainshed. The building will be of fire-proof construction. The first three stories will be of dark granite on the main front, while the upper part and the other sides will be of buff mottled brick. The roof will be covered with dark glazed Spanish tiles. Adjoining the building will be a trainshed 600 ft. long by 136 ft. wide.

PROPOSED NEW TERMINAL STATION AT CHICAGO, ILL.; ILLINOIS CENTRAL R. R.

The first and mezzanine stories of the building will be devoted to waiting rooms, ticket offices, and other offices for the use of the public. Special provision has been made for the accommodation of suburban traffic, and ingress and egress can be had from the platforms and special waiting room without the necessity of entering the main station building. Carriages will drive from Park Row into a large covered court.

The principal ticket offices will be on the street level. Provision has been made for passengers to check their baggage and by means of subways reach the train platforms without the necessity of going upstairs into the waiting rooms, which will be in the portion of the building extending over and above the tracks, and forming, in addition to the office building, a structure about 150 ft. square. Private waiting rooms for ladies, a smoking room, restaurant accommodation, and other conveniences have been provided for. The rotunda, or general waiting room, will be 100 ft. by 150 ft., with a large, circular domed roof. Wide stairways are provided from this room connecting with all passenger platforms, and to avoid the necessity of incoming passengers having to pass through the waiting room, provision has been made by well-lighted subways carried under the tracks for entrance from Twelfth St., Park Row, and the covered carriage court. The cost of the station, including main building and trainshed, is estimated at $900,000.

THE NEW INTAKE FOR THE MILWAUKEE WATER-WORKS.

In our issue of Oct. 25, 1892, we described and illustrated the new intake for the Milwaukee waterworks. This intake is designed to take water from Lake Michigan, about 8,000 ft. from the shore, at a point where the water is 60 ft. deep. A tunnel 7½ ft. in diameter and nearly 140 ft. below the surface of the lake will extend to a crib some 3,000 ft. from the lake, located over a lake shaft. From the crib two parallel lines of 5-ft. cast iron pipe, each 5,000 ft. long, will be laid in a shallow trench and terminate in submerged cribs.

Last fall difficulties were encountered which stopped work on the tunnel. Mr. George H. Benzenberg, City Engineer of Milwaukee, has very kindly sent us an account of these difficulties, together with a brief statement of the method of overcoming them and some facts regarding the progress of the work and the prospects for its completion. We cannot do better than to quote from Mr. Benzenberg's letter, as follows:

The work on the new tunnel and intake progressed quite satisfactorily until last fall, when the contractor struck a heavy body of water in the heading which he was not prepared to properly take care of; hence the tunnel and shaft were flooded. Quite a number of but partially successful attempts have been made to recover the shaft and tunnel, but as the tunnel is 140 ft. below the lake surface, the contractor had a great deal of trouble in lowering his pumps in the shaft, until about three or four weeks ago, when he successfully recovered the work, building a brick bulkhead with gates, pipes and valves to control the flow of water near the end of the tunnel about 50 ft. from the heading. He has since cleaned out the tunnel, replaced the track and flooring, and has permanently placed three large pumps in the tunnel near the shaft. Upon an examination, made yesterday (April 5) of the heading and the openings through which the water is pouring in at the rate of about 1,200 gallons a minute, I have come to the conclusion that the water comes from above, but doubt that it has a direct connection with the lake.

As blasting is necessary to remove material to be excavated, I do not think it quite safe to proceed in the original direction of the tunnel, and have, therefore, decided to make a detour to the south for a distance of about 65 ft., hoping that we may thereby possibly avoid the crevice through which the water seems to be pouring into the work. Work in the

new direction was commenced this morning (April 6), and should we be able now to proceed without any further accident, the tunnel may be completed by September next, when we shall be able to supply water from the new crib at the end of the tunnel.

About 1,000 ft. in length of the double line of 5-ft. pipe was laid last fall. Work will commence again as soon as the lake will permit, with the hope that possibly we may complete laying the pipe before the end of the year, when we shall be able to take water from a depth of about 60 ft. below lake surface.

TESTS OF STRUCTURAL WROUGHT IRON AND STEEL.

The discussion on the paper read by Mr. Alfred E. Hunt, at the Glen Summit meeting of the American Institute of Mining Engineers, and published in our last two issues, was of especial interest and value, as it brought out an expression of the views of representative manufacturers. We condense it as follows:

Mr. W. H. Morris, of the Pottstown Iron Co., said that some years ago wrought iron plates were made without any tests, and they were always satisfactory to the company's customers. With the general introduction of testing it came to be customary to employ outside parties to make the tests, and at the same time inspect for surface defects. As it is quite human to magnify one's services in business, especially when one's pocket is at stake, requirements were piled one on another, and the corps of inspectors was largely increased. The more the inspecting to be done, the more help was required to do it, and the more profit to the testing laboratories. This has worked serious injustice to the mills. They are required to handle their iron a second time, and sometimes oftener, because it does not suit the inspectors to be on hand when the iron is made. Sometimes the mills are kept waiting as long as a week, much to the detriment of the customers, especially on hurried work.

Some of the inspectors sent out know nothing about iron and steel manufacture, and some are young men fresh from the technical schools. These men must be educated at the expense of the mills.

Worse still, the inspector has now ceased to make a final decision on the acceptance of material, and the engineers claim the right to reject material at any time, even after it has been spoiled by punching and riveting, and is only fit for scrap. In the handling of a large business it is necessary to load direct from the shearing-bed; and for bulky articles, such as plate iron, this is particularly desirable, because the re-handling of such material is very expensive. The Pottstown Iron Co. rolls plates up to 8 ft. wide and 75 ft. long, and has rolled them over 100 ft. long.

Again, with regard to the number of tests, more and more are called for, without any appreciable gain to the consumer. When the mill is using a certain reasonably uniform kind of stock, one or two tests a day should certainly be a sufficient indication of the character of the product, and this ought to satisfy any reasonable buyer. The notion, sometimes set up, of making one or more tests on every car load is absurd. Such a requirement shows that people have either no confidence in the party they deal with, or no confidence in the uniformity of the material they buy. In that case, they might as well make a test of every piece. Again, the surface inspection should be made by the mills, and they should be relieved of any annoyance in this part of the work, at least.

Steel is recognized to be a better material for construction than iron, while it may be generally admitted that, from lack of experience we are not so familiar with its characteristics. Why should the tests for steel be so much more rigid than for iron destined for the same purpose? In other words, why should the minimum and maximum tensile strength be fixed within such narrow limits, even to 2,500 lbs. variation above or below the mean for steel, when no such thing is thought of for iron? If an engineer calculates his strain at 60,000 lbs., why should he find fault if he gets a somewhat stronger piece of steel, provided the other qualities are up to standard? If the strains are calculated on 60,000 lbs., why should fault be found if the material shows not more than 70,000, and gives at the same time the full elongation or reduction required?

Cold-rolling, which Mr. Hunt criticises, was brought about by these very requirements, it having been found that there is in steel, as indeed in other metals, a certain variation in physical qualities for the same chemical analysis. Does not the same statement apply to iron? When the Government will license a boiler for use on the high seas, merely specifying the reduction and the tensile strength, why should more rigid requirements be made for bridge steel, except that the bridge inspectors think it will make more work for them, or that some engineer has a hobby of his own?

With regard to the relative merits of open-hearth and Bessemer steel, the regularity of product is perhaps in favor of Bessemer, where it is confined strictly to one class of raw material. In the open-hearth practice, the time for tapping is judged by the melter, and hence necessarily varies according to his judgment and that of his partner on the other turn. In the case of a number of furnaces, there would be still greater variation. Delays in tapping present another uncertain contingency. In the Bessemer process, running on one grade of metal with a constant mixture and a regular measured quantity of blast, there is less room for irregularity; and any slight changes can be controlled by taking the tests from the next previous heat as a guide. In actual practice, it has been demonstrated that in this process variations can be controlled within very narrow limits, and misfits kept below 1 per cent.

Something is said by Mr. Hunt implying reflection on the honesty of the manufacturers in dealing with the inspectors and specifications. It seems to me that such suspicions are largely brought about by the inspectors themselves. Some inspectors come to a mill with the idea that they are hired as spies, and naturally feel aggrieved if they do not find something irregular to report. When a man is disposed to do what is right and reasonable, and has had any practical experience, I imagine he has little to complain of; but in many cases the inspectors are persons held to rigid instructions, with no judgment, or no right to use it, who report to some theoretical assistants; and of course there is bound to be a "hitch." No man is fit to have charge of inspection and testing who has not had some experience as a manufacturer.

I have known of an instance in which an assistant engineer came to the works with the expressed determination of showing that the iron was bad, and had it put to the most unreasonable strains, such as plunging into water while hot after being bent on itself flat, then opened up again cold, to try and separate the welds, and then nicking and breaking the piece for the same purpose. He felt very angry when he failed to prove that the material was bad, as he had predicted. I have also known a case in which an engineer took the position that he could inspect the material or not as he chose; that he could decide that the material was not fit to use, without even taking the trouble of looking at it; and he even went so far as to attempt to condemn it in that way.

The effect on the mind of a young inspector coming to a large works where many hands are employed, and finding, after he gets well seated in his position, that he can at will condemn a plate for a trifling defect, is very bad. He naturally feels, like Selkirk, that he is "monarch of all he surveys." Some inspectors have complained, on the other hand, that the mill-men considered them "poor cattle." All such collisions are, however, in my experience, fortunately rare. They would probably never occur, if the business were confided exclusively to practical men. A blacksmith who has outlived his ability to do heavy work would make a much better inspector than a green college boy.

It would be well if some specified thickness of metal could be established for test-pieces, especially in steel; and this, I think, is the custom in England as most soft blooms are sold on a guarantee of test at a 7-16 in. thickness. The U. S. Government also recognizes, in its requirements for the boilers and hulls of vessels, the difference in materials at varying thicknesses.

It is the custom of the Pottstown Iron Co. to make tests of its material for its own information; and every heat of steel has, in addition to four analytical tests, five mechanical ones. There is cast, for each heat, a 4-in. square test ingot, which is hammered down to 1¼ ins. square. This is nicked and bent cold, to see how many blows it will stand, both chilled and unchilled. Another piece is then hammered at the same heat to ⅝-in. square and bent both chilled and unchilled, each piece being nicked and broken, to show the fracture. Finally, a ⅝-in. piece is pointed, flattened out to ⅛-in. thick, split open from the point about 1½ ins., and two ¾-in. holes are punched, the first being ¼-in. from the end of the split and the second, ¼-in. from the first, and directly behind it. All this (which may be called preliminary work) is done at one heat, without much care to keep the conditions uniform. The remainder of the work, which forms the real test, is all done at a bright cherry-red, and great care is taken to keep the conditions the same for all tests. The ends of the split are bent down sidewise until the ends of the two parts touch the sides of the main test piece. Finally, the ¾-in. holes are drifted out to 1½ ins. The outer edges of the test piece, the division between the holes, and the base of the split, should be perfectly smooth and free from checks or flaws. This test, generally known as the "ear-test," forms an almost perfect measure of red-shortness, or shows the entire absence of that quality. All our material will stand these tests; and in addition the plates are tested for tensile strength in the mill, after being rolled.

The mere physical tests, as indicated by a testing machine, are not nearly so valuable as tests involving such exhaustive strains as these. One test of this kind for each cast of steel should be ample. Under Mr. Hunt's plan for tests, the ordinary output of a mill would involve 50 or 60 test pieces daily, which would be highly unreasonable.

If the different testing-bureaus would agree on one man for a given works, much trouble would be saved to the mills and to themselves. Often five or six men come to test and inspect relatively small shipments; and the cost of their pay and traveling expenses is a heavy burden for the consumer.

There is no reason why the chemical requirements for basic steel should be more rigid than for acid. The former is a softer metal and better adapted for uses formerly served by wrought iron. In heating it, any workman with experience in soft steel can do as well as on iron, if not better. Nothing is to be feared on this score. Soft steel slabs, made by our special processes, have been repeatedly heated as hot as iron piles without any deleterious effects. We have also piled and welded the scrap from such plates, and cut it up into nails, without discovering any signs of the welds. In fact, our steel scrap can be welded as easily as iron. We can get our phosphorus down below 0.01 and keep our manganese low, without any signs of red-shortness. We can make our tensile strength as low as 50,000 lbs. In short, we can make a metal as soft as lead, and from this to any required degree of hardness.

As a final comment on Mr. Hunt's paper, I would suggest the following principles to consumers and their inspectors:

1. Employ ordinary good business judgment in dealing with manufacturers in whom you have confidence; and this will secure, in return, their respect and confidence toward your inspectors.

2. When full tests are made regularly by the manufacturers, accept their tests in lieu of an excessive number of your own.

3. Allow the mills to make their own surface inspection, or else let your inspectors' acceptance of materials be final, as it used to be.

4. Always select as inspector a man who has had experience in making and working iron.

5. As far as possible, avoid the duplication of tests, and save expense for your customers and yourselves.

6. Adopt some standard thickness, as well as width, for your test pieces.

7. Make your specification as simple as possible.

8. Allow a leeway of 5,000 lbs. above or below the ultimate strength required, or else follow the Government requirements in accepting higher tensile strength, if the elongation shows corresponding increase.

9. Accept any material which is equally as good for your purpose as that which the specifications call for.

Mr. Wm. Kent said that a full interchange of views was needed between the manufacturers and the engineers; otherwise the engineers were likely to draw too severe specifications, and be too rigid in their requirements. Mr. B. E. Fernow referred to the advance which has been made in timber testing since the adoption of a standard size of test piece.

Mr. Oliver Williams, of Catasaqua, Pa., said that inspectors as a class had greatly improved during the last few years. Young men, fresh from technical schools, used to be sent out by the railway companies, whose ignorance of their business was only excelled by their assumption of knowledge, and by their earnest effort to condemn everything they could by any possibility take exception to. But at the present time men of experience and good judgment are generally assigned to the work of inspection.

A principal difficulty at present is that there is no generally accepted specification. Last week we had in our mills, at the same time, three or four inspectors, representing different bureaus, each one of which had its own special requirements, varying for plate iron from 46,000 up to 52,000 lbs. tensile strength, and from 5 up to 15 per cent. elongation. As Mr. Morris well observes, one inspector could have attended to all these orders at a considerable saving of expense, and with comfort to himself as well as to the manufacturer.

Another point is, that some railroad and bridge companies have raised their requirements, and yet are not willing to pay the necessary price to obtain a high class of material. It is a general opinion that iron is not produced to-day of as good quality as 15 or 20 years ago; but I claim that never in the history of the trade were mills making as good iron as they are generally producing to-day. There is now no difficulty in getting an iron that will meet the most rigid requirements, if the consumer is willing to pay for it. They call for "double-refined" iron, for instance, and there are mills to be found (although they are few) which will take old rails, work them down twice, and stamp the product "double-refined." This, of course, can be done at comparatively small cost; but honestly made "double-

refined" iron cannot be made for the price that is now being paid by the bridge companies.

The remedy for present evils, as all admit, is a reasonable and uniform standard specification for both steel and iron. As a manufacturer, I would say that the Bridge Builders' standard specification meets my views. There are, no doubt, some requirements in it that are too low to suit many of our engineers, but these can readily be modified, and, in some instances, raised, to suit their ideas. Take it all in all, it is, in my judgment, a specification that we can meet, and meet honestly.

Some specifications come to us, more especially from the West, asking for iron of very high tensile strength, say 52,000 lbs. and over, and no other requirements named. Every manufacturer knows that this single requirement can be readily met, and yet the iron may be practically worthless. When the railroad companies will employ engineers who are well posted in iron and steel making, specifications will be furnished that can be met fairly and fully, and a material will be supplied that can be depended upon every time.

I trust the discussion of this subject will result in doing away with some of the annoyances and unnecessary expenses to which mills are now subject. The railroad people may think that it is the manufacturer who is paying these unnecessary bills, but in the end they come back on the consumer. I give away no trade secret in saying that.

I wish to emphasize my concurrence with the point made by Mr. Morris concerning the inspection that does not inspect. It is becoming a custom not to consider the inspection at the mill as final; and after material has been once accepted, it is frequently rejected in the bridge shops. This will inevitably lead to trouble and litigation in the near future; and it is very important that settled rules governing this final rejection should be agreed upon by the parties in interest.

* * *

In connection with my observation that consumers are often not willing to pay for the special qualities they require, I will give an instance from my own experience. A few years ago I hit upon a mixture of metal that made an admirable railway axle. The requirements of a certain railroad company were that their axles should stand two blows of 1,640 falling 10 ft., and three blows of the same weight falling 15 ft. I offered to guarantee for my metal double the weight, double the height of fall, and double the number of blows, for 1 ct. extra per lb.; but the offer was refused.

Dr. C. B. Dudley, Chemist of the Pennsylvania R. R., said: The key-note to the situation in inspecting materials is the fact that if the manufacturer knows that his product is going to be subjected to some test, whatever it may be, the material that you get will be better than if there were no testing at all. This remark involves no reflection on the business integrity of manufacturers. It expresses simply our understanding of ordinary human nature. We all know that everybody does a little better when he is watched. It is this fact, that there is some one on watch, if I may say so without accusation of conceit, that gives a portion of its value to the testing department of the Pennsylvania R. R., with which I am connected.

Some years ago, as many will remember, there was a little contest over the quality of steel to be used in rails. At the beginning of that contest, a good friend of mine, who is at the head of an establishment which has been a perfect marvel of business success, remarked, substantially, "What is the use of our paying any attention whatever to quality? We can sell more rails now than we can make." That was one side of the question—the simple business proposition of getting rid of the output of a mill, no matter what it turned out, and of making money out of it. This, you will understand, was 12 to 15 years ago. I do not think you will find that spirit now.

Now, between the perfectly legitimate and proper desire of the manufacturer to make money by turning out as much material as he can, and getting all he can out of his plant, and the fact that the man who uses the metal has got to take risks in connection with it, the real conflict comes. It is a common opinion, I think, among manufacturers who have to furnish material, and among what we call "supply men," that specifications are almost all written "out of a man's head." That is not true, as I know; for I have written a good many of them. I do not sit down to write a specification and call for what I think would be ideal material. I have never done anything of that kind, and I am the less inclined to do it the older I get. I know that there is a possible tendency on the part of a man fresh from school to think that he knows it all; but such a man is, of course, hardly fit to write a specification. The specifications that issue from the motive power department of the Pennsylvania R. R. have a tangible and sensible reason for every requirement they contain.

It is our custom, when we take hold of a new subject for which a specification is to be ultimately made, to examine first the good and bad material from actual service. Then, after a preliminary draft of the specification is prepared, it is sent to all the manufacturers interested and to the mechanical officers of the company for criticisms. Even after the specification is put in force, it is revised from time to time as the need of changes become apparent by experience.

To illustrate the reason for the requirement that steel shall not exceed a certain tensile strength: It was desired to strengthen a Howe truss bridge, and so the 1¾-in. iron rods in the first two panels at each end were replaced with steel rods of the same diameter which showed 96,000 lbs. tensile strength and 22 per cent. elongation. The strain on these rods from uniform loading was not more than 8,000 lbs. per square inch, yet these rods broke one after another. The cause of the breakage was that the nut on the end of the angle-block did not have an even bearing. The steel rods were too stiff to bend and equalize the strain over the whole section, as did the iron rods. Again, boiler plate steel of 75,000 lbs. tensile strength cracked and broke up in flanging, although it showed over 25 per cent. elongation, in the testing machine.

Mr. Eckley B. Coxe instanced the inspection of coal as an example of the good effects of outside inspection of some kind in raising the grade of the product. There are two things in "coal," coal and slate. Nobody objects to the latter, just as nobody objects to water in brandy, provided there is not too much of it. Some time ago the department having charge of the preparation of coal made its own inspection, and the result was constant complaints of the quality of coal from customers. The difficulty was solved by placing the inspection in the hands of the sales department, who placed an agent at the mines with instructions not to bill a carload of coal unless it was satisfactory. There was a good deal of "kicking" for the first month, but now no one would go back to the old plan. The quantity turned back by the inspector is not a hundredth of one per cent. of the total output. The main reason is that every slate picker, every screen boss, every man about the breaker, knows that the inspector is there and that carelessness is likely to cause the return of a car, which will detain a part of the force after 6 p. m., and the blame for this will be brought home to somebody.

Thus, even in separate departments of a business under a single ownership, it has been found desirable to provide for the inspection of the product by parties independent of the work of production.

Dr. R. W. Raymond said the granting of degrees by the colleges upon examinations conducted by the teachers of the candidates was like the manufacturer inspecting his own product, and resulted in cheapening the value of the distinction. Within the limits of one and the same business, it is highly important that both the inspection of the product and the auditing of accounts (which is also a kind of inspection), should be separated from the manufacturing department altogether.

He agreed with Mr. Morris and Mr. Williams that the acceptance by an inspector should be final. There is no justice in a vague, indefinite responsibility. It may be because the engineer thinks he can rectify by subsequent rejection any carelessness or ignorance of the inspector that he is willing to let a young fellow, without the necessary experience, do the testing.

One thing more, and it might be made the text for a long discourse. Unnecessarily severe requirements always involve lax enforcement. Reasonable and practicable conditions can be and ought to be strictly enforced. Maximum requirements frighten away sometimes the honest bidders, and invite those who either do not understand what they are promising or rely on evading its performance in some unworthy way.

Giving wide discretion to the inspector is not the best remedy for this vice in the specifications. It is not fair to the manufacturer or the inspector that the letter of the specifications should be so unreasonable as to require to be set aside. Better demand less, and be more sure that you get it. We put our severity in the wrong place.

Mr. Walter E. Koch, of the Spang Steel & Iron Co., of Pittsburg, said he regarded the following tests as the best:

1. A straight test piece, 20 ins. long, properly prepared for 8 ins. in the middle, should be pulled, and the elastic limit, ultimate strength, elongation, and reduction of area noted.

2. Annealed plates or bars should be tested after annealing.

3. The drifting test, if done fairly, and in presence of the maker's representative, is a good one. It has been in use in some places for years.

4. The cold-bends and quench-bends are both essential—especially the latter for steels running above, say, 0.18 in carbon.

5. One test per melting heat should be the minimum.

6. I would never allow an inspector to stamp rejected material. This was tried once in Scotland, and had to be abandoned.

7. I am strongly in favor of having all inspection done at the mill before shipment. The "coupon" system is unfair. "Audi alteram partem" should be the motto over every testing room; and, surely, both parties should be represented at so important a time. Moreover, much delay and trouble is often occasioned by the coupon system, to say nothing of accidents caused by the projecting coupon.

8. I think, also, that inspectors should be made conversant with the methods of manufacture. In this way mutual confidence is established to the great advantage of both parties.

Mr. John J. Williams, of Youngstown, O., described his experience in getting a structural iron works in operation, and turning out a satisfactory grade of metal, and the difficulties encountered in dealing with inspectors not properly qualified for their work. These difficulties, however, had been overcome, and inter course with the inspectors had been for some years as pleasant as could be wished. Both sides had got beyond the suspicion line.

For structural iron, 50,000 lbs. tensile strength, 25 per cent. elongation, and 30,000 lbs. elastic limit is a fair formula. Higher figures may be reached with careful selection of material and unceasing vigilance at every stage of the process; but those who require so much in ordinary market purchases run great risk of failure.

He was strongly opposed to Mr. Hunt's suggestion that inspectors should be permitted to note and report on methods of manufacture. The final judge of results ought not to be also the critic of the means by which they are attained. If the inspector has previously approved the method of manufacture, or, perhaps, has even suggested improvements in it which the management has adopted, he must be prejudiced in favor of the results; and, if he does not like the methods, or has made suggestions which were not accepted, he will be tempted to find in the metal he inspects the faults which he is sure his rejected advice would have prevented. "When it becomes necessary for me to permit the process of manufacture to be supervised by inspectors who have the power of finally rejecting the product, while I bear the responsibility of the business, my place will be open for a successor."

Mr. Gus. C. Henning said that the methods of testing now in use had been introduced gradually by engineers or individual inspectors, and in spite of strenuous objections from the mills and shops. Ten years ago very little testing was done, and that under widely varying conditions. It seems perfectly proper that the party who buys material should have the right to say what tests shall be applied and that the mill manager shall say how the material shall be made.

In a properly written specification the tests to be made are clearly defined. The expense of testing is not large, except when the material is not satisfactory, and particularly when the contractors have not properly studied the requirements before making their bids.

It seems evident that the engineer has the right to call for any number or kind of tests at a definite charge for each kind of test, agreed upon in advance, and to be paid by the engineer. Every mill manager must know the precise cost of all kinds of tests, as thousands of them are made; hence this item of expense should never be in doubt. If a given profit be added to the cost of making tests, no complaint can be made as to their number. It is only bad practice to leave so important a matter to arbitrary arrangement after contracts have been signed.

There should also be no trouble in obtaining the material from which to cut test pieces; for if shapes are properly cropped, and not pared off as scantily as has become the practice in some mills, there will always be sufficient on hand for this purpose. The argument that test pieces must not be cut from crop ends because these are not good material is not a sound one. If the material is unsatisfactory on one side of a shear cut, it cannot be satisfactory on the other side immediately adjoining. A crop end should be so long that there can be no doubt about the quality of the remaining material. The argument that it is expensive to have large crop ends or much scrap is only partially true, because the only loss, as a rule, is not at all the cost of material cut off, but mainly the cost of labor required to reconvert it into a merchantable shape (except in such works as do not make steel, but purchase it elsewhere and merely roll it). It is, however, probable that in some of our rolling mills, where, by reason of lack of proper system, the total wastes are greater than the total profit of an English mill, testing and cropping may cause extraordinary expenses.

Quoting from well-known specifications, such as those of Bouscaren, Vaughan, Cooper and the Bridge Builders' so-called "standard specifications," we find the following requirements:

The first (Bouscaren and Vaughan) has been called severe and difficult to fill, and is generally declared to be too rigid, although without reason; the second (Cooper's) is often adhered to, and answers well for

(Continued on page 440.)

SCHEDULE FOR STANDARD EFFICIENCY OF AIR BRAKES.

The following is the revised schedule for a standard efficiency of air brakes, as revised by the M. C. B. committee after the meeting held at Chicago, April 22, 1892. This schedule is subject to further revision, but is not likely to be very materially changed otherwise than by filling the blanks below. It will be seen to have been very considerably expanded from the original draft, published by us early in April.

Conditions for Tests.

1. Brakes will be tested on a rack representing the piping of a fifty 34-ft. car train. All cocks, screens, angles and connections will be identical as nearly as possible with those in train service. A drawing will be submitted, showing what shall constitute the proper fittings, piping, dimensions of cylinder, auxiliary reservoirs, main reservoirs, engineer's valve, etc.

2. Pressure.—Tests will be made with a uniform train pipe pressure of 70 lbs.

3. Construction of Triples.—Triples must be constructed so that they can be secured and operated on apparatus conforming to diagram, Plate 2. (Not issued yet.)

4. To secure accuracy in measurement of time in application and release tests, electrical recording apparatus will be used.

5. Tests shall be repeated at least three times under the same general conditions. The temperature at the time of the tests will be recorded.

TESTS.

Schedule of Tests.

1. Application Test (a).—Brakes must commence to apply on the 50th car in three seconds, or less, from the first movement of the engineer's valve handle, and must indicate at least 55 lbs. in the cylinder of the 50th car in 3½ seconds, or less, from the first movement of the engineer's valve handle. This test will be made with: (1) 6-in. piston travel; (2) 12-in. travel; (3) 4-in. travel.

(Note.—The object of this time limit is to secure in actual service a minimum length of stop and shock, and break-in-twos.)

2. Application Test (b).—Commencing with the fifth car from the engine, the air from the reservoirs of three successive cars will be cut out, the brakes will then be applied as per test (a). The emergency action should pass these three cars and apply on the 50th car in the same time as in test (a). Tests will be made with piston travel of 6, 12 and 4 ins.

(Note.—In freight service, the most common method of remedying a defective brake, is to cut the brake out; hence it is essential that a limited number of cars can be cut out successively without destroying the emergency feature.)

3. Graduating Test.—Seventy pounds train pipe pressure having been secured, the following tests will be made:

(a) A reduction of 10 lbs. in train pipe pressure. This should lightly apply the 50 brakes.

(b) A further reduction of 4 to 6 lbs. This should increase the braking power on all the brakes.

(c) A reduction to 30 lbs. should equalize the pressure between the auxiliary reservoirs and brake cylinders. The piston travel in this test will be 6 ins.

4. Test to Determine the Sensitiveness of the Emergency Valve.—Three valves selected at random will be taken for this test, and each tried separately. The engine and tender brake should be connected in. A train pipe pressure of 70 lbs. having been secured, the air will be discharged as rapidly as it may, through an opening in the engineer's valve of .. inches. Under this condition the emergency action must not take place.

(Note.—The object of this test is to check the introduction of triples, which will cause an emergency application when not wanted.)

5. Tests to determine the holding power of the brake in service application and emergency application:

(a) Service Application.—Gages will be placed on the cylinder and auxiliary reservoir of the 1st, 25th and 50th car, with 70 lbs. train pipe pressure. Brakes will be applied by admitting as nearly as may 15 lbs., into the cylinder of the first car. Record of pressure in the auxiliary reservoirs and cylinders will then be taken at the first application and at 5, 10 and 15 minutes thereafter.

(b) Emergency Application.—This will be the same as above, except that all the air will be exhausted from the train pipe.

6. Release Tests.—The following conditions should be observed in this test: (a) Boiler pressure 160 lbs.; (b) main reservoir cut out; (c) pumps 8 in.; steam cylinder, 7½ in. air cylinder. A uniform pressure of 70 lbs., having been secured in the train pipe, all the air will be exhausted by an emergency application. The train pipe will then be pumped up to .... lbs., and a record of all brakes that have released taken.

(Note.—This test, in addition to testing the release feature of the triples, is intended as an equivalent to a break-in-two in train service.)

7. Test to determine the time of charging one auxiliary reservoir:

(a) Cut out the car to be tested at the cut-out cock.

(b) Bleed the auxiliary reservoir empty, and close the bleed cock.

(c) Secure 90 lbs., pressure on main air reservoir and train pipe.

(d) Shut off the pump.

(e) Cut in the car to be tested and note from the reading of the gage and time occupied in charging to 70 lbs., the time should not exceed .... seconds, nor be less than .... seconds.

(Note.—The object of this test is, to prevent irregular charging of auxiliary reservoirs, and thus assure that the front brakes will not apply after charging.)

Train Tests.

1. In order to provide against defects which a rack test may not develop, it is recommended that railways make a 50-car train test in actual service before accepting the result from the rack test as final.

2. In making application tests Nos. 1 and 2 with a train, the measurement of time from the first car to the 50th car should also be provided for. This will determine the time occupied by the engine brake as against the car brake.

3. Special care should be taken with the engine and tender brakes in order that they may do their share of the braking during the stops, and not pull away from the train.

4. All brake shoes must have a proper bearing on wheels, which is best accomplished by giving them some previous service before testing.

G. W. Rhodes, Geo. Gibbs, E. B. Wall,
Committee.

PERSONALS.

Mr. H. H. Pendleton has been elected City Engineer of Independence, Mo.

Mr. J. Y. McClintock has been elected City Surveyor at Rochester, N. Y.

Mr. C. F. Kohlman has been appointed City Engineer, and Mr. J. L. Evans, Assistant Engineer, at Racine, Wis.

Mr. J. C. Warren has been appointed Acting Superintendent of the Panama R. R,, with headquarters at Colon, U. S. Colombia.

Mr. Geo. S. Morison has removed his Chicago office to the Temple, corner of La Salle and Monroe Sts. His New York office remains at 35 Wall St.

Mr. Nathan A. Baker has been appointed Vice-President and General Manager of the projected Denver, Apex & Western Ry., vice Mr. Geo. W. Miller, resigned.

Mr. James McBeth has been appointed Superintendent of the Adirondack & St. Lawrence Ry., with headquarters at Herkimer, N. Y. He is also Superintendent of Motive Power and Rolling Stock.

Mr. George F. Gardner, Superintendent of the Zanesville & Ohio River Ry., has accepted the position of General Superintendent of the Cincinnati, Lebanon & Northern Ry., with headquarters at Cincinnati.

Mr. W. D. Lee, Assistant Superintendent of the Rio Grande Southern R. R., has been appointed Superintendent of that road, with headquarters at Ridgway, Colo., vice Mr. D. M. Ridgway, who has been appointed Division Superintendent of the Denver & Rio Grande R. R.

Mr. J. A. McNicol has been appointed Engineer and Manager of the Hamilton Bridge Co., Hamilton, Ont. He has just completed the Mystic drawbridge on the New York, Providence & Boston R. R., which is discontinuous when carrying train loads and continuous when swinging.

Mr. F. Schneider, Assistant City Engineer at Milwaukee, Wis., has been appointed one of the three Commissioners of Public Works, and will be succeeded by Mr. Edward Kuhlmann. Mr. Geo. H. Benzenberg is President of the Board of Public Works by virtue of his position as City Engineer.

Mr. Charles Francis has been appointed Chairman and Supervising Engineer of the new Board of Public Works, at Davenport, Ia. Mr. Francis was born at Lowell, Mass., and began work as an engineer in 1866, serving for some years with the late Mr. E. S. Chesbrough, and later being engaged on irrigation work in California, and railway work in Mexico. He has for some time been in practice at Davenport, and was in charge of the rebuilding of the Government water power dam at Rock Island, Ill.

Mr. Daniel Adee, formerly a well-known publisher, and the first manufacturer of cast steel in America, died at East Williamsburg, N. Y., April 25. He was early apprenticed to Harper Bros. In 1845 Mr. Adee went into the manufacture of cast steel, the first time it was attempted in America. His works were on Second Ave, New York, taking up the whole block between 46th and 47th Sts. They were known as the New York Cast Steel Works, and were afterward moved over to that part of Long Island known as Furman's Island, on Newtown Creek, and the name was changed to the Continental Steel & Iron Works. The company received medals for its exhibits at the Crystal Palace Exhibition in London. In 1870 the Continental Iron & Steel Co. failed, owing to the shrinkage in values that took place after the war, and Mr. Adee went back to the printing business.

Mr. E. S. Nettleton, C. E., of Denver, Colo., will sail for Europe April 28, accompanied by his son, E. G. Nettleton, C. E., of Nampa, Idaho. Mr. Nettleton has a commission from the United States Government to investigate irrigation systems in Spain, Northern Italy and Southern France. Especial study will be made of the economic use of water for irrigation and the effect of long continued irrigation upon land. Mr. L. G. Carpenter, Professor of Irrigation Engineering in the Colorado State Agricultural College, Fort Collins, Colo., will join Mr. Nettleton in Europe during the summer and will also study irrigation there. Mr. Nettleton was at one time State Engineer of Colorado. He had charge of the Eastern division of the irrigation work recently done by the U. S. Geological Survey and since that work was terminated has been the engineer in charge of the artesian and underflow investigations, made by the U. S. Department of Agriculture, and recently terminated.

NEW PUBLICATIONS.

RECORD OF SCIENTIFIC PROGRESS FOR THE YEAR 1891. Exhibiting the Most Important Discoveries and Improvements in all the Branches of Engineering, Architecture and Building, Mining and Metallurgy, the Mechanic Arts, etc. By Robert Grimshaw, M. E., Ph. D. New York: Cassell Publishing Co., 12mo., pp. 372. Well indexed: $1.50.

If some one will undertake to get out a thoroughly well digested and complete annual record of this nature, not endeavoring to be too "previous," by describing as "Progress" schemes which are still wholly in the air or which imply no scientific progress if carried out, but confining the work to a record of actual achievement, he will have a real field open to him, and we should expect to see such a work successful.

Dr. Grimshaw, however, has not blocked out his plan properly, if our idea of what it should be is correct, and therefore, even had the execution of his plan been much better than it is, it would not "fill the bill." It is perfectly evident that the less frequently any serial publication is issued the less "newsy" it should attempt to be, and the more careful that everything it records should be accurate. No one expects, or has a right to expect, that daily papers will be very accurate in their "Record of Scientific Progress." Their function is to catch wisdom as well as folly as it flies, and not to stop to find out whether it is really wisdom or folly either. The technical weekly is bound to be much more careful, and yet it also must record the news while it is still news, and so describe or chronicle many things whose permanent importance it has doubts about. A monthly should be more careful yet, a quarterly more careful yet. It goes without saying that an annual should be the most careful of all, or it is naught.

We cannot better describe in a word both the good and bad points of Dr. Grimshaw's work than to say that the several items read as if they might have been prepared for or cut from some daily newspaper which was rather more than usually careful to gather in all the technical news of importance, and to avoid the usual glaring errors and absurdities of the newspaper reporter. The items are written in the popular daily newspaper style (we do not mean a bad style), varying from two lines to two pages in length. Many of the items are very interesting, and not a few of them are novel to us, but for an annual they are prepared with unpardonable carelessness. For example, we read on page 87: "On nearly all of the leading English lines the best trains have Pullman sleeping or drawing room cars," which is an absurd exaggeration. On page 90 we notice the ludicrous statement that "The air for the drills in tunneling (Transandine Ry.) has been conveyed by electric cables." On page 117 we find "tebebate" for "tepetate." On page 121 we are told that "The Channel tubular railway," proposed by Sir Edward Reed, "is to run," in tubes of steel, and in fact, the phrase "is to run," "is to have," or "is to cover" is used in dozens of places for dubious schemes which have so little chance of amounting to anything that they ought not to be described at all in an annual of this kind.

Similarly we have on pages 123-4 a description of a proposed North River bridge, which, in the first place, is not described in the right location, the one specified being that for Mr. Lindenthal's bridge, and, in the second place, gives detailed specifications as to the design, which we infer was taken from unauthorized newspaper reports, as we have been very recently assured that the company has as yet adopted no design. We are also told on page 132 that aluminum "is to be used" in "some" of the towers of the public buildings

of Philadelphia, instead of cast iron, "thus saving 400 tons in weight," when the fact is, that the proposition is all in the air at best, and relates only to one tower of one public building.

So we might go on with a long list of dubious or trivial information improperly given. On the other hand, we had noted and might give a very considerable list of important facts which should be given, but are not; but we cannot give the space. We are, perhaps, treating the book too seriously, as if it were meant for scientific men instead of "to sell" to the uncritical multitude. But it has just merit enough to make us wish that it was better. The conception is good, and with the addition of references to fuller sources of information, and a little more care in regard to the selection of matter, it would make a useful publication. As it is it is readable, and, if read with due caution, is even instructive.

DIAGRAMS, FORMULAS AND TABLES FOR BRIDGE ENGINEERS AND ARCHITECTS. By Malverd A. Howe, C. E., Prof. C. E. Rose Polyt. Inst. Printed for private circulation; 4to. pamphlet. pp. 38; 30 diagrams; 25 cts.

This convenient compilation, as we judge it to be, is a reprint of a series of articles contributed to "Mechanics" during 1890. There is absolutely no "reading matter" in the ordinary sense, nor discussion of the merits or demerits of formulas, but the idea was to give in compact form, with only so much text as was necessary for clearness, the formulas, standards, etc., used by American engineers in designing roof or bridge trusses, and to add (when they did not already exist) diagrams and tables for lessening the labor of applying these formulas. Hence there is nothing to review, except the judgment and fairness shown in including or excluding formulas, and the accuracy with which the information is presented. In both these respects the compilation seems to be unexceptionable, and we should judge that it would be appreciated and valued by a good many engineers.

INVENTIONS LIKELY TO TAKE AND PAY IN INDIA AND THE EAST. Henry H. Remfry, Calcutta, 1892. Pamph., 8vo., pp. 32. Rs. 3 ($1).

The purpose of the writer, who is a patent agent, is to call attention of inventors in India to the advantages of patenting their inventions, and he specifies some particular inventions or contrivances which appear most required in India at the present time, by which it seems that nothing can come amiss. It is said that one of the most pressing needs of the country is the general introduction of useful inventions and cheap contrivances, to enable its natural resources to be turned to better account.

THE IRON FOUNDER; A Comprehensive Treatise on the Art of Molding. By Simpson Bolland, Practical Molder and Manager of Foundries. New York, John Wiley & Sons; 12mo., pp. 382; 308 illustrations; $2.50.

The author states that his principal object in writing this book has been to help such of his fellow-craftsmen as have been shut out from the wider experience which he has enjoyed. Although some space is devoted to pattern working and some reference is made to such subjects as foundry ovens, crystallization and shrinkage of cast iron, pressure in molds, mixture for rolls, etc., most of the book is devoted to the molder's work in dry sand, green sand and loam. We notice no reference to the use of molding machines in the work, which is an omission of considerable importance in view of their increasing use. Something on the molding and casting of cast iron lathe tools would also have been of interest. For the class of men to whom it is addressed, however, the matter in the book seems to be well chosen and of practical value.

KANSAS STATE BOARD OF AGRICULTURE.—Report for 1891. M. Mohler, Secretary, Topeka, 8vo., pamph., pp. 91; many tables.

This report shows in detail by counties the amount and value of the agricultural products of the state in 1891, and other statistics of interest. A paper by Mr. Robert Hay, a geologist, treats of the "Water Conditions of Western Kansas" and shows how water may be developed for irrigation by tapping the underflow with canals and by sinking wells. A paper entitled "Irrigation on the Western Plains," by Mr. Wm. Tweeddale, C. E., states that the only practicable means of procuring water for irrigation in Kansas is by developing gravity flows from ground water near the surface or by pumping from wells. Pipe distributing systems are recommended as preferable to open canals.

BREADSTUFFS IN LATIN AMERICA.—Bureau of American Republics, Washington, D. C., 1892 8vo., pp. 91.

This bulletin contains statistics of the commerce in breadstuffs between the United States and the several countries of Central and South America and the West Indies, during the last ten years, together with the capacity of these countries for production, and the extent to which they derive their supply of cereal products from the United States. The world's wheat crop for 1891 is given as 2,352,587,497 bushels, of which 611,780,000, or over 25 per cent., was from the United States.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF GEORGIA, for the year ending Oct. 15, 1891. Pamph., 8vo., pp. 120.

The report is taken up almost entirely with the commissioner's tariffs and classifications and the discussion of the complaints arising therefrom. There is nothing of technical interest.

NEW YORK RAILROAD CLUB.—New York, 1892. Pamph., 12mo., pp. 21.

This number contains a paper on "Economies in Maintenance of Way," by Mr. Benjamin Reece with discussions on that paper, and on "Steel Freight Car Trucks," being the proceedings of the meeting of March 17 (Eng. News, March 26).

TRADE PUBLICATIONS.

MATHEMATICAL INSTRUMENTS AND DRAWING MATERIALS. Catalogue of L. M. Prince, Cincinnati, O. 8vo., pp. 122.

ENGINEERING AND ASTRONOMICAL INSTRUMENTS. Descriptive catalogue and price list of Geo. N. Saegmuller (Fauth & Co.), Washington, D. C. 8vo., pp. 96; 50 cents.

The instruments described and illustrated are generally high grade ones for exact surveying or for astronomical work. Full descriptions are given of the Saegmuller solar attachment and shifting plate for tripod head. Judging from the fact that a prominent page is devoted to telling the properties of aluminum, the manufacturer is prepared to make instruments of that metal.

MECHANICAL STOKERS.—The Brightman Stoker Co., Cleveland, O. 8vo., pp. 32.

This pamphlet illustrates and describes the Brightman mechanical stoker and smoke preventing furnace, as applied to different forms of boilers. The coal is fed from hoppers and forced on to the dead plate by a reciprocating "pusher." The grate bars are inclined downward from the dead plate at an angle of about 34°. The bars are fitted with lugs to retain the coal, and have a continuous reciprocating motion.

SOCIETY PROCEEDINGS.

NEW ENGLAND RAILROAD CLUB.—At the meeting on May 11, the amendments to the Rules of Interchange, especially rule 8, will be discussed. A paper will be read by Col. F. H. Forbes, on the railway system of Massachusetts, 50 years ago.

ENGINEERING ASSOCIATION OF THE SOUTH.—The regular meeting was held at Nashville, Tenn., April 14, Vice-President F. P. Clute in the chair. The paper of the evening, entitled "Municipal Engineering in Chattanooga," by Mr. Jas. A. Fairleigh, of Chattanooga, was read in the absence of the author. The paper presented the system of organization and control of the department of public works and engineering of the city, giving also the amounts of appropriation and expenditures in the city during the past two years, together with the amount of asphalt, granite block, brick, and block asphalt streets in use, with the cost of same and an exhibit of the mileage and cost of the sewers of the city. There are 9 miles of brick and 33 miles of pipe sewers.

ENGINEERS' CLUB OF ST LOUIS.—At the meeting on April 20, President Johnson in the chair, Mr. B. F. Crow read the paper on "Elements Involved in Rapid Transit." The subject was divided into two parts, first, the development of a new system, and, second, the study of methods to increase the efficiency of lines already in existence. The second method is the one in which the greater number are interested. One of the greatest drawbacks to rapid transit has been the poor roadbeds and poorly designed curves which answered the purpose for the horse cars, but were inadequate for the present system. The terminal facilities was another point which made trouble when it was attempted to run a number of trains with a small headway. The question of stops was one which presented serious difficulty to obtaining any high rate of speed. The paper also dwelt on the question of car construction and showed some of the advantages obtained by newer and better designs.

A paper by Prof. Howe on "The Maximum Stresses in Drawbridges" was announced for the next meeting, May 4. Arthur Thacher, Secretary.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on April 20, President Cohen in the chair, there was a discussion of the preliminary report submitted at the annual convention by the Committee on Uniform Methods of Tests of Material Used in Metallic Structures. Mr. H. B. Seaman, one of the committee, made a brief statement of the purpose of the report. He stated that Mr. Gilpin, of the Pennsylvania R. R., had had samples of the same material tested on different testing machines, with very varying results, showing that records made on different machines are not comparable unless the machines are equated. The variations were less with screw than with hydraulic machines, and the former was considered the most reliable, though its fault is in being too slow in operation. Mr. L. L. Buck did not think it possible to have any standard, as different kinds of tests will be required for steel for fireboxes and that to be forged or made into eyebars. Any standards must be government tests, as manufacturers cannot be expected to throw away their testing machines and adopt a uniform type of machine. Mr. Geo. S. Morison considered it advisable to make tests from the finished bar or shape. In recent specifications he provided for test pieces 1 in. square, a variation of 4,000 lbs. either way from the specified ultimate strength, and the elongation to be the ultimate strength, and the elongation to be measured on a length of 8 ins. He considered it wise to specify certain chemical limits, especially low phosphorus, so as to secure uniformity and reduce the amount of testing required, as it is desirable not only to secure the material desired, but to secure it with a minimum of trouble. For this reason he prefers to specify and pay more for open-hearth steel on account of its greater uniformity than Bessemer steel. Mr. Henning advocated tests for surface hardness of cast iron for bed plates under bridge roller bearings. Test pieces for transverse tests should be over 30 ins. length. The shoulders affect the turned portion of test pieces, and the length between shoulders should be 8 ins. plus twice the diameter of the section. He considered the hydraulic testing machine to be the best if properly used. As to the reduction of area test he did not think it reliable, owing to the difficulty of measuring the irregular fractured surface. Mr. Bush said that tests from angles and channels had showed the material to gives different results than when made into plates.

Mr. R. L. Harris made a brief reference to a successful method adopted by him for dealing with quicksand by the injection of cement, which process is described elsewhere in this issue. Considerable interest was shown in the process and in the samples of material exhibited.

COMING TECHNICAL MEETINGS.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
May 2. Secy., C. L. Annan.
ENGINEERS' CLUB OF ST. LOUIS.
May 4. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
May 4. Secy., F. Collingwood, 127 East 23d St., New York.
June 8. Annual Convention, Old Point Comfort, Va.
WESTERN SOCIETY OF ENGINEERS.
May 4. Secy., J. W. Weston, 280 La Salle St., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
May 5. Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
May 6. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
May 6. Secy., O. von Geldern, 319 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
May 7. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
May 7. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
May 7. 1122 Girard St. Secy., J. C. Trautwine.
ENGINEERS' CLUB OF KANSAS CITY.
May 9. Baird Building. Secy., H. Goldmark.
WISCONSIN POLYTECHNIC SOCIETY.
May 9. Loan & Trust Bldg., Milwaukee. Secy., M. Shinke.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
May 10. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
May 10. Secy., C. S. Howe, Case Library Building.
NORTHWESTERN SOCIETY OF ENGINEERS.
May 10. Occidental Block, Seattle. Secy., E. H. Warner.
DENVER SOCIETY OF CIVIL ENGINEERS.
May 10. Secy., Geo. H. Anrell, Jacobson Block.
NEW ENGLAND RAILROAD CLUB.
May 11. United States Hotel, Boston. Secy., F. M. Curtis.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
May 12. Secy., O. H. Landreth, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
May 12. Secy., Edward Mead, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
May 13. Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
May 14, 194 Third Ave. Secy., H. Schreiter.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
May 14. At Roanoke. Secy., J. R. Schick, Roanoke, Va.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 16 to 20. San Francisco, Cal. Secy., F. R. Hutton, 12 W. 31st St., New York.
AMERICAN WATER-WORKS ASSOCIATION.
May 16. Secy., J. H. Decker, East Orange, N. J.
WESTERN RAILWAY CLUB.
May 17. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
May 17. Secy., E. N. Clark, Pittsburg, Pa.
BOSTON SOCIETY OF CIVIL ENGINEERS.
May 18. Secy., S. E. Tinkham, City Hall.
ENGINEERS' CLUB OF CINCINNATI.
May 19. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
May 19. Secy., T. G. Pihlfeldt, 118 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
May 19. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
May 19. At 12 W. 31st St. Secy., H. G. Prout, 73 Broadway.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
May 19. Secy., C. H. McLeod, Montreal, P. Q.
MONTANA SOCIETY OF CIVIL ENGINEERS.
May 21. Secy., F. D. Jones, Helena.
CENTRAL RAILWAY CLUB OF BUFFALO.
May 25. Secy., Jas. Manbeth.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 6, 7. Grand Pacific Hotel, Chicago. Secy., E. W. Pope, New York.
NEW ENGLAND WATER-WORKS ASSOCIATION.
June 8, 9, 10. Holyoke, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
AMERICAN RAILWAY MASTER MECHANICS' ASSOC'N
June 20. Saratoga, N. Y. Secy., A. Sinclair, New York.
AMERICAN INSTITUTE OF MINING ENGINEERS.
June 21. Plattsburg. Secy., R. W. Raymond, New York.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York. Entered at the Post Office, New York City, as Second Class Matter.

VOL. XXVII. THURSDAY, APRIL 28, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The meeting held on Tuesday of this week at Pittsburg has approved, with one sole exception, the preliminary schedule of tests for car couplers proposed by the Master Car Builders' committee having that matter in charge, as announced in another column. The exception was a change of very doubtful expediency, it appears to us; namely, an increase in the proposed tension test from 100,000 to 125,000 lbs. The drop test, which is surely the most important of the whole, was left as originally drawn up, viz., five blows of a 1,640-lb drop, falling 10 ft. three times and 15 ft. twice. This last is a pretty severe test, and yet it only means that the 1,640-lb weight will strike three blows at about 16 miles an hour and two at about 21 miles. Considering the enormous weight and considerable speed of trains which come together in coupling, it is obvious that drawbars are continually receiving heavier blows than that, and except for the easing effect of the springs the test would by no means be severe enough. As it is, it surely is not too severe, considering that the fracture must be complete, and not a mere crack, before it is counted against the coupler. On the other hand, a dead pull of 100,000 lbs. (50 tons) must approach very closely to the ultimate limit of practice, even when some severe jerk occurs; and the effect of such a jerk is more likely to cause a local fracture, as a blow would, than to search carefully for the weakest point as a dead pull does. We doubt very much if couplers as now used ever fail under anything resembling a dead pull except when they have been previously weakened by blows; but they continually fail under impact. Therefore, it would seem advisable to lay all the stress possible on the blow tests, and make them as severe as possible, since high tensile strength and high impact resistance are to a certain extent antagonistic to each other. The complete series of tests which are to be made at some time in the future will settle this point, it is true, for the couplers will undoubtedly be tested to destruction however many blows it takes; but the change may lead some makers to go off on a false scent, and so do them an injury. Were we preparing couplers for such a test we should give them all the impact strength possible regardless of any other test. We think there is no doubt that such couplers will be preferred by buyers, and make the best service record.

In connection with the paper of Mr. Yarrow on the vibration of vessels, published elsewhere in this issue, we wish to call attention to the ingenious instrument which is there described and illustrated, and which has been appropriately christened a "vibrometer." In its essential features the instrument is simplicity itself, consisting merely of a heavily weighted drum suspended by elastic connections from a substantial base, and slowly revolved by clockwork. When the instrument is placed on a vibrating surface, as the deck of a vessel, the base of the instrument, of course, vibrates with this surface. The weighted drum, however, tends by its inertia to remain at rest, and its elastic connection with its support permits it to do so, approximately. Thus a pencil attached to the stand can be made to trace a "vibration diagram" upon the drum as it revolves.

This instrument, in Mr. Yarrow's hands, has led to a knowledge of the causes of vibration in screw steamers, and thus to an efficient method of prevention; but there is no apparent reason why the instrument should not be applied to the study of vibration in other structures, such as bridges and buildings. So far as we now recall, in such studies of the vibration of bridges under load as have been made, a fixed structure of some sort has been built beside the bridge, and the records have been obtained by attaching a pencil either to this structure or to the bridge (a). While this method has the merit of accuracy, provided the fixed structure is itself free from vibrations due to wind, water currents, etc., it is at the same time a cumbrous and expensive method with structures of any size, and on bridges of very long span over deep rivers it is wholly inapplicable.

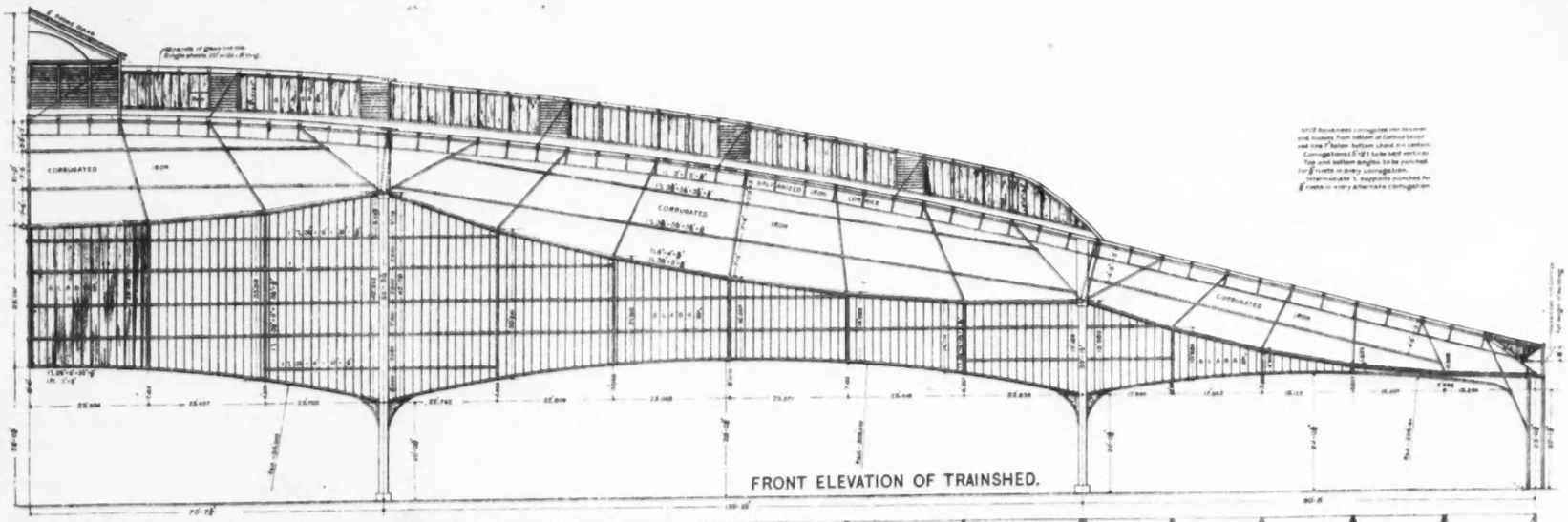
The type of "vibrometer" described by Mr. Yarrow, however, requires no fixed structure beside the bridge. It can be set on the track or on the floors of any building, and diagrams can be taken with it more easily than indicator cards from a steam engine. It is, moreover, so simple in construction that any machine shop should be able to make one satisfactorily. The important point in its construction is merely to secure abundant elasticity, so that the natural period of oscillation of the drum will be much longer than any of the vibrations it is intended to measure.

(a) See reports of investigations by Prof. S. W. Robinson, Report of Ohio State Railway Commissioner for 1884, Appendix, p. 51. Also, Trans. Am. Soc. C. E., Vol. XVI., p. 42.

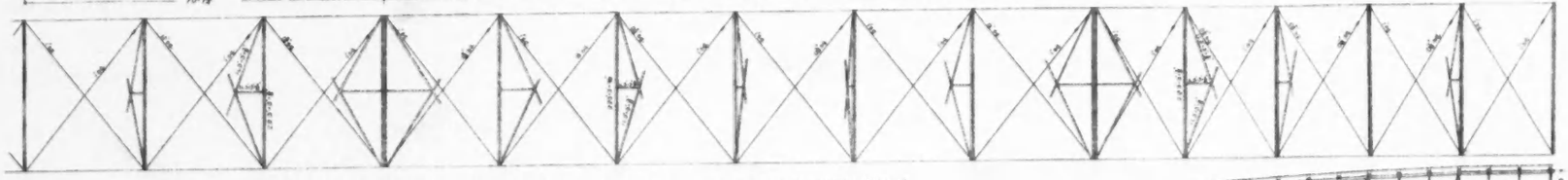
An examination of a large number of city engineers' reports substantiates the previous impression that these reports have an average value considerably below those made by water-works officials. This is especially true so far as both classes of reports relate to the character and extent of the works under the charge of the officials named. The one point in which many city engineers' reports excel is in the giving of detailed prices for work performed. This is an important point; the very fact that such figures are given attesting their importance, since such meager reports would naturally contain only those facts in which their authors were most interested. This state of affairs is easily explained. The office of city engineer is seldom held in such high esteem as it deserves by the tax-payers and governing bodies of our cities. The pay of the office is generally light and the work heavy. The incumbents must rely largely upon private practice for a living, except in a few cities. Therefore they cannot be expected to make exhaustive reports. In addition many municipalities would not publish the reports if made. Still the value of these reports might be largely increased without much expenditure of time in preparation or money in publication, and some kind of an annual report might always be brought out. We had occasion, about a year ago, to praise the report of Mr. Geo. Hopper, Superintendent of the water-works of Manhattan, Kan., for the admirable report which he published on one side of a small sheet of paper. We may now praise a report from a Kansas town of much greater size and pretensions, that of Mr. Lewis Kingman, City Engineer of Topeka. Mr. Kingman, we believe, has submitted reports heretofore, or has been willing to submit them, to the City Council, but these reports have not been published, at least not for general distribution. This year Mr. Kingman has brought out a summary of the work of his office for the past three years. Like Mr. Hopper's report, mentioned above, that of Mr. Kingman's compresses much valuable information onto one side of a sheet of paper. In conclusion, it is interesting to note that so large a city as Albany, N. Y., had in 1891, for the first time, an annual report from its city engineer, although the office has been in existence since 1800. Mr. Horace Andrews is now city engineer of Albany, and has the honor of making this innovation there.

One of the silliest notions which can afflict an engineer, or any other professional man, is that he "knows it all," or is expected or wanted to do so. Long established professions like medicine and the law got over this foolish notion long ago. The doctor or lawyer not only does not regard it as a sign or confession of ignorance to ask advice from others of his own profession, but he does this often on very slight occasion to satisfy clients, to make assurance doubly sure, or from a kind of professional esprit which makes it seem the proper thing to do as magnifying his own importance and indicating his own watchful care of his patient's or client's interest. But engineers as a class have not yet risen to this height. The less qualified, even more than the well qualified, seem to have a dread of asking that some other engineer be called in for consultation. They seem to think that the mere admission that two heads are better than one (for that is all it amounts to) will be taken as a confession that they do not themselves know all that they ought to, or all that there is to know. And when, in fact, they do not know all that they ought to, they seem especially to dread to confess it, and take the wildest kind of chances rather than do so. The only exception to this rule, and that only a partial one, is in the case of bridge construction. The consequences of attempting to design a bridge without knowing how to do it are apt to become so immediately and painfully evident that men fear the consequences of pandering to their own conceit in that line, and usually act more rationally. But when it comes to laying out sewers or railways, or building dams or roads, or a dozen things of that kind, they have no immediate catastrophe to fear and give their own conceit full play.

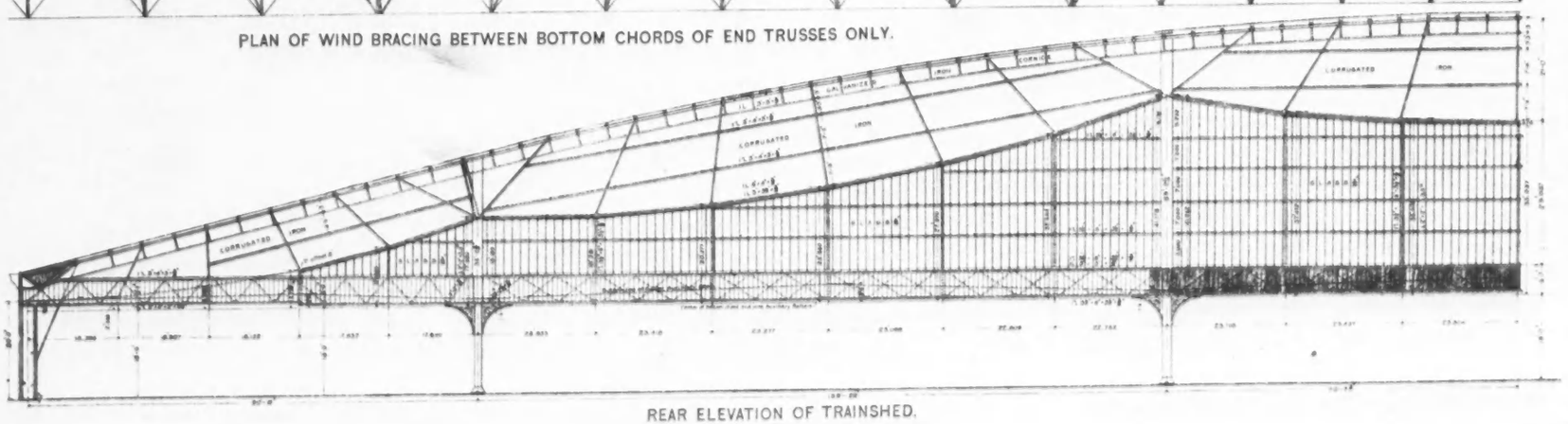
The city engineer of a prominent western city has recently got himself into trouble and lost his position by a display of conceit of this kind, and we have small sympathy for him; only just enough to keep his name and abiding place out of this notice. He was suddenly called upon to design a system of sewerage, and this was evidently out of his line, although he may be very well qualified for the numerous other duties of a city engineer. Under these circumstances (if not under any circumstances), what he should have done was to have gone to his city fathers and said: "Gentlemen, this is an important piece of work, and I would like to make sure that I have given you the benefit of the very latest and best practice in every detail. I may have overlooked something, and there may be some weak place in the design which I shall not detect until too late. I would like to call in one or two specialists for consultation before we go ahead further. The $500 or $1,000 which this will cost will not be very dear for insurance, if we get nothing further from them." Would his city fathers have thought any the less of him for so doing? Not a bit of it. They would have rather respected him the more, and had more confidence in him, because he was willing and anxious to submit his plans to expert criticism. He would have done a good turn to one or two other engineers (which they might remember to his advantage), to the city and to himself. What this city engineer actually did do was just the contrary. He availed himself of this opportunity to get up some strictly original designs, and proceeded buoyantly to put them into execution. Their "original" features soon excited criticism, and an expert was called in, who had no recourse but to condemn a dozen different features of the plans for good reasons stated. Out goes the city engineer, out go his beloved novelties, and out goes the impression broadcast among the public that after all it is better not to have anything to do with engineers if one can help it, as they never agree, and most of them do not know much, anyway. In this way much harm is done to the profession in general.



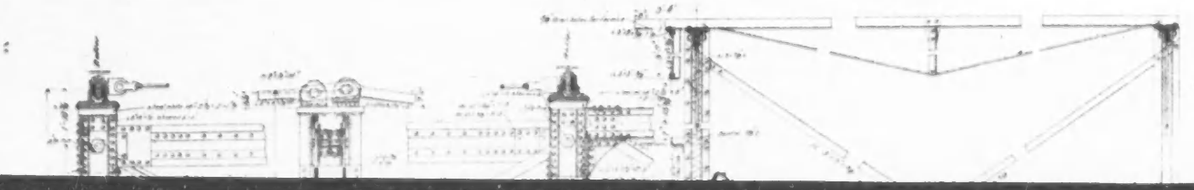
FRONT ELEVATION OF TRAINSHED.

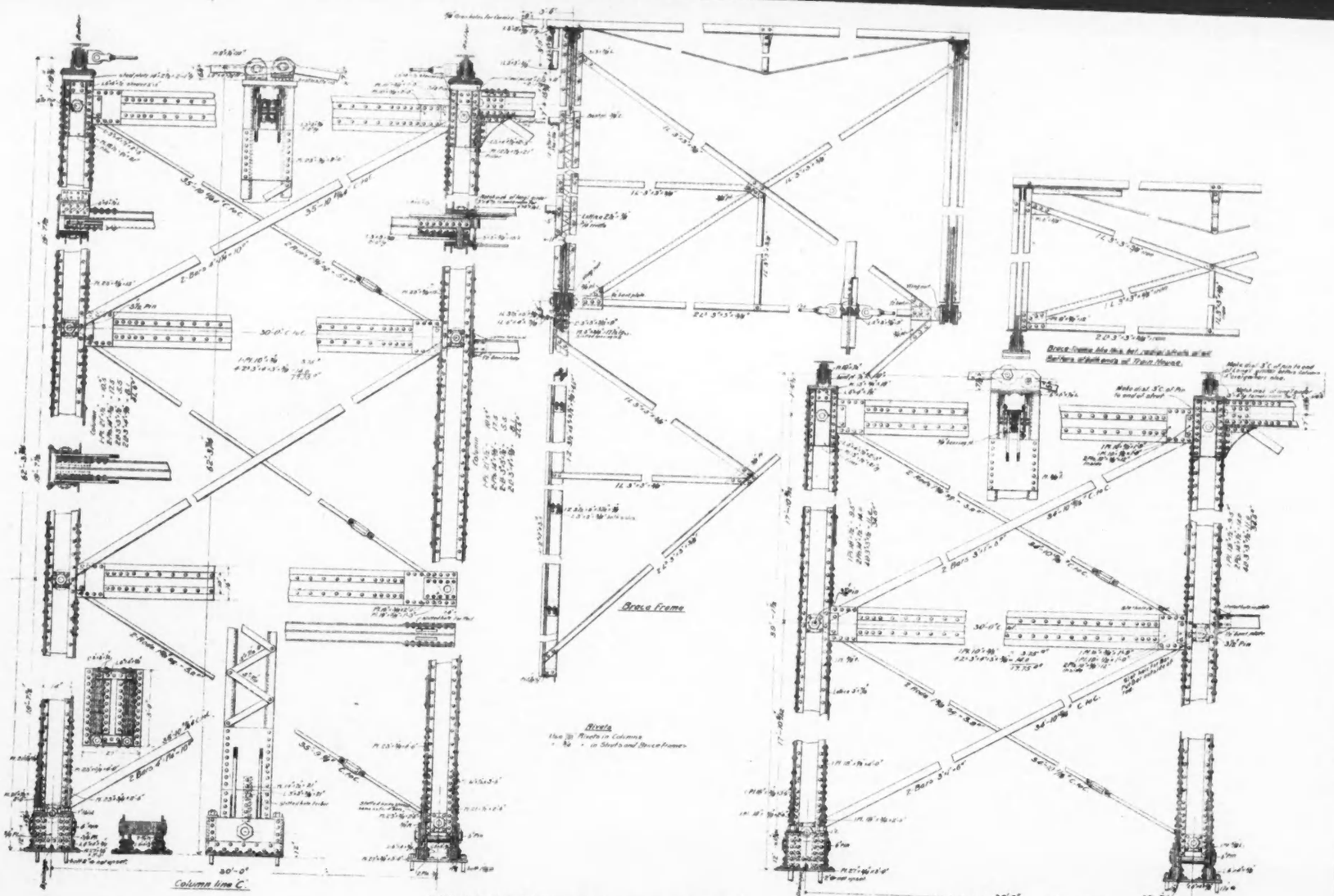


PLAN OF WIND BRACING BETWEEN BOTTOM CHORDS OF END TRUSSES ONLY.

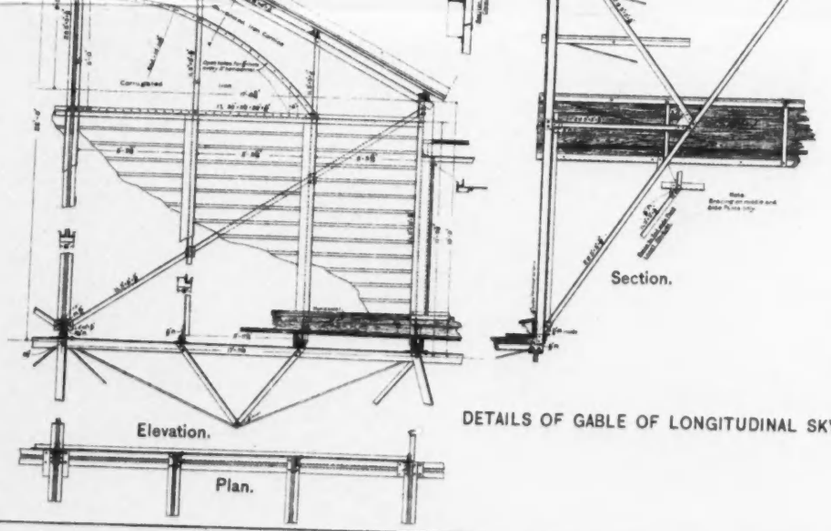


REAR ELEVATION OF TRAINSHED.





DETAILS OF WIND BRACING AT FRONT OF TRAINSHED.



Section.

Elevation.

Plan.

DETAILS OF GABLE OF LONGITUDINAL SKYLIGHT.

TRAINSHED

FOR

THE NEW UNION PASSENGER STATION,

ST. LOUIS, MO.

Geo. H. Pegram, Engineer.

CHAS. HART & SON, LITH., 26 VESEY ST., N.Y.

STANDARD SPECIFICATIONS AND TESTS.

As most of our readers are probably aware, committees of both the Mechanical and Civil Engineers' Societies are endeavoring to formulate a standard code for testing materials. The former society has had a committee at work on the subject for several years. The Civil Engineers' committee was appointed about two years ago, and has just presented a "preliminary progress report." The leisurely manner in which the committees are proceeding with their work does not warrant the expectation that their labors will be completed at any very early date. The fact seems to be that engineers generally do not appreciate the increasing need of a standard code for tests of structural material, and we may say, also, of certain standard specifications. There is great interest felt, as we have daily evidence, in such matters as the substitution of steel for iron, the trustworthiness of basic steel, the proportioning of sections to strains in the various members of a structure; but there seems to be comparatively little interest in the progress toward uniformity in tests and specifications.

It is worth while, then, to inquire why the adoption of standards is desirable. In the first place, it is well to remember that a great many bridges and other important structures are still built, the purchasers of which ask no aid from engineers. They contract with some bridge company or its traveling agent for a bridge, so wide and so long, the plate on the end post to have names of the Town Commissioners, Street Superintendent, or whatever officials have the matter in charge. There the purchasers' specifications end, and the builders supplement them, as a rule, with such specifications as they choose. There is no need to enlarge upon the defects of this system in these columns. No doubt reputable bridge companies build good bridges in their way; but there is no less doubt that the system gives the incompetent and unprincipled bidder, or the one whose traveling agent is the best talker, a great advantage over the bidder who has a reputation to sustain. The well worn plea that purchasers should rely on manufacturers' reputation and not on the specifications of "theoretical" engineers does not apply here, for what does the average village commissioner know of the reputation of different bridge companies?

On the other hand, the purchaser of a bridge who employs an engineer to look after his interests has first the invaluable assurance that the matter of the strength of the bridge has been investigated by one who had no financial interest in making it as weak as he dared. If the engineer is competent, the purchaser may rest assured that the bridge is safe. Further, and quite apart from the question of safety, if the engineer does his duty the purchaser will secure the most strength in his structure for the least money. It is this second part of an engineer's duties which is, perhaps, not always appreciated. If the public realized that the employment of an engineer meant a better bridge for less money, there would be fewer light-weight bridges built at a high price, and it is perhaps not too much to say that the converse is true, and that if engineers appreciated their duties in the direction of true economy there would be greater demand for their services.

On another page of this issue we publish a most interesting discussion on the subject of testing, giving the views of some prominent manufacturers. While there is some of the old argument that the maker's reputation is a better reliance than the results of tests, the consensus of opinion seems to be that purchase by specification and approval of the purchased article by regular tests has come to stay, and that it bodes no ill to the manufacturer. To an impartial observer there seems no room for doubt on this matter; the use of specifications and tests is extending into all branches of trade, and the benefits arising from their use are such that there seems to be no chance that they will be discarded.

But, on the other hand, it may as well be confessed that the iron and steel manufacturers are not without grounds of complaint. Engineers are neither perfect nor infallible. Many of them are prone to the riding of hobbies. Most of them are less familiar with structural material and its testing than are the manufacturers; and, realizing this, in their desire to make sure of safety in any event, they draw specifications and require tests more strict and severe than is necessary for their client's interests.

The early specifications were brief and confined to essentials; but their growth during the past few years has been a rapid one. The engineer found that disputes were frequent between his inspector and the contractor as to what was the "good workmanship" which the specification called for, so he added detail after detail to the specifications to cover the points in dispute. Knowledge of the behavior of metals under strain has also been marvelously increased, and the result of each new set of experiments has not infrequently been an added clause to the specifications.

This, we believe, is a fair statement of the process by which the bridge specifications at present in use have attained their voluminous size, and there is a tendency to make them still larger to cover more details of shop work and design, and to permit more thorough testing of materials.

On the other hand it is objected to these voluminous specifications that they defeat their own object, the really important requirements being buried in such a mass of matter that contractors will not take the trouble to study the specifications before bidding. They will trust to luck to escape with some profit on the contract. On the whole, it is not to be wondered at that the manufacturers look with less respect on the specifications than do engineers. As Mr. W. H. Burr said in his discussion of Mr. F. H. Lewis' recent specifications, "The literature of superstructure specifications indicates, I think, that engineers are not entirely agreed as to the matter or the manner of the things to be specified." Thus one specification makes no mention of what another specification lays stress upon; and there are not wanting those who say that the design of some details, which is commonly not specified at all, has more to do with the real strength of bridges than many things which are fully set forth in the specifications.

But, notwithstanding the complaints which are made of the length of bridge specifications, they seem much more likely to grow in size than to decrease. The objections to a long specification apply chiefly to such as are wholly new or those which are little used or used by a single engineer. If bids are asked for a certain structure to be built according to a standard specification, the contractor knows at once what will be required of him.

If a contract is to be thrown open to all bidders it is an advantage to the reputable manufacturer to have the character of work which will be required minutely specified; and, therefore, the tendency seems likely to be toward the use of standard specifications covering in fullest detail design, material and workmanship.

The time when every bridge engineer made his own specifications or considered himself competent to do so is past, and the use of such specifications as those of Cooper or Bouscaren is very general and is on the increase. Possibly the profession will permanently continue to rely on the work of a few prominent engineers; but it seems more likely that sooner or later a movement will be made toward the adoption of a standard specification, which will represent to a greater degree than any now available the opinion of the body of the profession upon all well established points. In such a specification there should be no place for hobbies, or for requirements concerning whose necessity there is general dispute. But it should contain all the detail in reference to shop work necessary to compel at least safe work by even the most tricky contractor.

It may be objected that the adoption of such a standard specification would mean the suppression of individuality and of progress; but this need not be the case. If such a specification covered only the generally accepted details, the engineer using it would add such other requirements as he deemed necessary. The contractor could easily estimate the importance of such additions and coyld regulate his bid accordingly.

But before a standard specification for bridges must come standard requirements for their material; and to formulate these requirements, or rather the tests by which the material is to be proved, is the task which the engineering societies have undertaken.

In the discussion of Mr. Hunt's paper on tests, which we reprint elsewhere, one prominent manufacturer said: "I trust the discussion of this subject will do away with some of the annoyances and unreasonable expenses to which the mills are now subject. The railway people may think that it is the manufacturer who is paying these unnecessary bills, but in the end they come back on the consumer."

Certainly in the formulation of a standard code of tests criticisms like these should receive attention. No tests should be called for which can be justly characterized as unreasonable. It is probable that a large proportion of the excessive requirements and severe tests of which manufacturers complain are due to the attempt of engineers to economize by the use of high unit strains in connection with an extra grade of material. There is much reason to believe that this policy is a mistaken one, and that the greatest strength with the least outlay is secured by demanding and securing good material merely. The extra expense of the highest quality metal can be applied to increasing the section of the members, thus increasing their life and their resistance to wear and corrosion.

It is true that those who specify an extra grade of material are not always willing to pay an extra price for it, and they may sometimes be successful in obtaining something better than the regular output of good material from the mill without paying much more for it. In the long run, however, all the good material which is produced by the mill must be worked off; and it is said that those who demand an extra grade of metal do not always get such good material as they imagine and as they base their calculations on. Certainly if they do get it, they should be willing to pay what it is worth.

The bulk of engineers are, doubtless, united in requiring for their work only such good metal as the mills can regularly produce at reasonable cost. The proposed standard code of tests should provide only for such tests as are sufficient to determine this. Engineers who wish to use the highest grade of metal in special structures can easily add such tests as they deem necessary, and raise the requirements to such a point as they please.

It is, of course, true that sufficient tests should be required to prove the toughness of the metal and provide for ample safety. It is also true that every encouragement should be extended to manufacturers to raise the grade of their product. These ends can be secured, however, without unduly multiplying tests or demanding what a first-class mill's regular output will not furnish. Additions to the standard code of tests can be easily made, as occasion requires, and can be estimated by contractors at their real importance, enabling them to adjust their bids accordingly.

The effect of such a standard system of tests would be to raise the general average of structural material.

Manufacturers who have contented themselves with ordinary work would exert themselves to raise the character of their product, if a standard were established and generally recognized. The chief benefit of a system of standard tests, however, would be the effect on the practice of engineers. The investigations of both the Civil and Mechanical Societies' committee have shown that the greatest diversity exists among engineers as regards the tests in use and the methods of making them. Among all these variations in practice there must be some best system, and if it can be found and its qualities proved, the gain to the profession will be a great one.

The New York Central & Hudson River R. R. will elevate its tracks near, and build a high level bridge over, the Harlem River, a bill having been passed authorizing the road to elevate its tracks between 106th and 135th streets. It provides that half the expense of the work below the Harlem River shall be paid by the city, and that the work shall be done under the supervision of a commission to be appointed by the Mayor. Mr. Depew, president of the railway company, has stated that as soon as the Mayor appoints his commission work will be begun on the Harlem improvements. He thought that it would take about a year and a half to complete the work, which will consist of a new bridge over the Harlem, and elevated tracks above and below the river in place of the present depressed and surface tracks. The entire cost of the work will be about $3,000,000 and the city's share will be $750,000.

LETTERS TO THE EDITOR.

AN AUTOMATIC SIPHON.—EXPLANATORY.

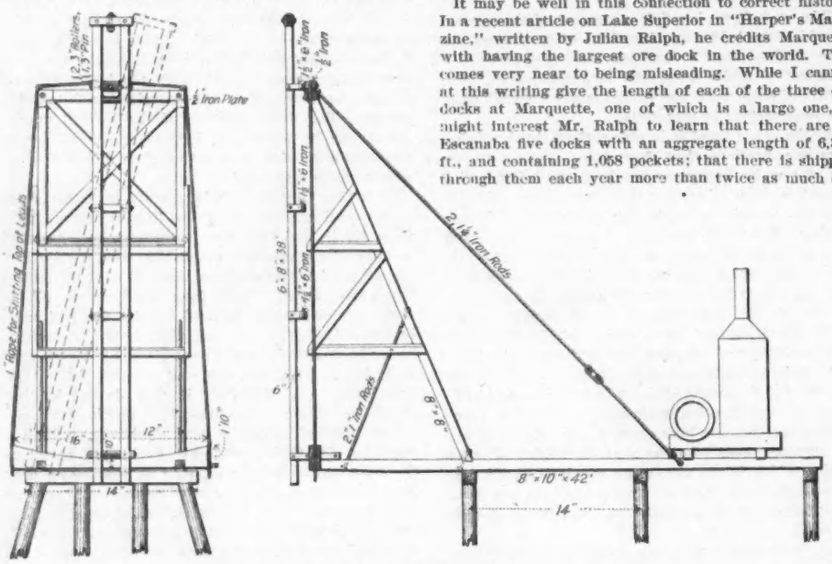
Sir: On page 385 of your April 16 edition you describe a siphon which is automatic. This siphon was patented by Wm. G. Rhodes, of Philadelphia, Pa., Dec. 17, 1878. Yours, etc. Flush Tank Co.

Chicago, April 18, 1892. Chas. Poore, Secy.

PENDULUM LEADS FOR PILE-DRIVER.

Sir: I send you a sketch of a pendulum lead "top pile-driver," designed for shifting top and bottom of leads. It will be seen that this driver can be utilized in driving piles in places where neither a ground nor a boat driver can be used.

If, though, some specified kind of pile driving is required whereby the piles have to be driven in accordance with a certain fixed plan, then this driver can be simplified by drawing the tops of the two shear braces together, making the top of the leads stationary and doing away with the two shifting rollers and ropes. The pendulum feature can be retained by leaving the bottom of the leads free to be shifted to any position.



PILE DRIVER WITH PENDULUM LEADS; J. M. Jackson, Engineer.

It is claimed for this device that it will do pile driving of all kinds, to conform to any specification, and will do the work cheaper, quicker and in a more workmanlike manner, than any other form of pile-driver.

It can be used on construction work as a top driver, pulling itself ahead on completed work, and it can be used to great advantage for maintenance of way work mounted on a flat car, or for river and harbor work mounted on a boat.

The sketch as sent you is designed for top work, and all parts are made as light as is possible for sufficient strength. If a driver is required for any other kind of work, where weight is not material, then all the parts should be made much stronger and bracing more substantial. This driver is not an experiment, but has been used successfully by me on several large pieces of construction work. J. M. Jackson.

Schenectady, N. Y., March 19, 1892.

IMPROVEMENTS TO THE CHICAGO WATER SUPPLY.—CORRECTION.

Sir: In my statement on improvements of Chicago water supply, submitted to you and published in your issue of April 21, 1892, a serious error occurs. On page 407, second column, second line from top, instead of "Intake is in 7 ft. of water," it should read: "Intake is in 26 ft. of water." Bernhard Feind.

First Assistant City Engineer.

Chicago, April 25, 1892.

MICHIGAN AND CUBAN ORE DOCKS.

Sir: Noticing in your issue of April 9 the plans of the Cuban ore docks, it is interesting to note that the plan is commending itself abroad as well as at home. So far as I know, all the American ore docks are now built on this plan; certainly the north Michigan, Wisconsin and Minnesota docks are. It is curious to notice how coolly the plans are copied (in some instance pirated) and no credit given. The plan was originally designed by the then chief, now consulting engineer, of this company, and the first dock built by it was dock No. 3, in this harbor, in the winter of 1879-80, under my supervision. To show how radical was the departure in structural arrangement I inclose a sketch showing the universal method of construction up to that time. It is a plan of our old dock No. 1, as it existed up to two years ago last fall; and is substantially identical with the old docks as Marquette and L'Anse, the only other points in the Lake Superior district where iron ore docks were then in existence. In the old plan it will be noticed that the partition bents reach from sill to deck, and short posts, capped, support the pocket floors. In the new plan all the posts are cut off under the pocket floor, the deck being supported by short bents resting upon the floor. The curved section chute of sheet iron was also a feature in this new plan, the old chute being a wooden trough lined with sheet iron.

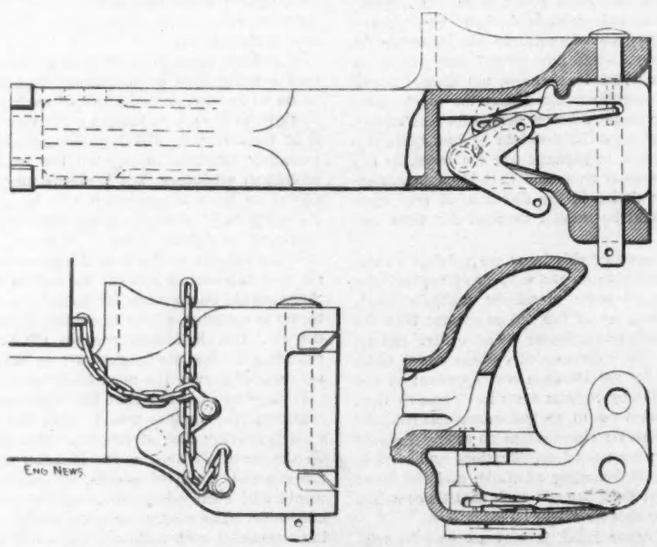
It may be well in this connection to correct history. In a recent article on Lake Superior in "Harper's Magazine," written by Julian Ralph, he credits Marquette with having the largest ore dock in the world. This comes very near to being misleading. While I cannot at this writing give the length of each of the three ore docks at Marquette, one of which is a large one, it might interest Mr. Ralph to learn that there are at Escanaba five docks with an aggregate length of 6,348 ft., and containing 1,058 pockets; that there is shipped through them each year more than twice as much ore as passes through the Marquette docks, and that about 44 per cent. of all the ore mined in the Lake Superior region passes through the docks at Escanaba.

Yours truly, C. Palmer,
Div. Engr., C. & N. W. Ry.

Escanaba, Mich., April 18, 1892.

THE EMPIRE CAR COUPLER.

We illustrate herewith a new candidate for favor in the M. C. B. coupler field. Those controlling it base their chief claims to recognition upon the manner of locking the knuckle and the fact that the knuckle can be positively opened from the side or the top of a car.



AN M. C. B. COUPLER WITH LOCKING AND OPENING DEVICE; Empire Car Coupling Co.

The locking device consists of a rock-shaft journaled in the coupler head, and carrying on its inner end an arm, made in one piece with it. The end of the rock-shaft, which projects from the side of the coupler head, has two arms for chain connections. One of these chain connections is made fast to the end sill of the car, and in case the tail bolt pulls through, the knuckle is unlocked automatically, releasing the coupler and preventing it from being pulled out to fall upon the track. The other chain is connected to an arm on a shaft running across the end of the car. If desired a connection may also be made to the top of the car, so that the unlocking shaft may be turned from either side of the car or from the top.

Combined with the unlocking shaft is the knuckle opening device, which is a simple rod connected to a ⅝-in. pin in the side of the coupler knuckle. The rear end of this rod is slotted, giving opportunity for the rock-shaft to turn far enough to lift the lock before the knuckle begins to open.

All the unlocking and coupler opening gear, with the exception of the end of the rock-shaft, is inclosed by the walls of the coupler head, and is thus protected both from mechanical injury and from clogging by snow or ice. The lock has a bearing surface against the tail of the knuckle of 5 to 6 sq. ins., giving ample area to prevent wear. The knuckle is designed to meet severe buffing strains by providing a fillet at the hinge joint. The body of the coupler is made of malleable iron by the Cleveland Steel Castings Co., and the knuckle is made of cast steel by the Johnson Foundy & Machine Co., of New York City. The coupler is put on the market by the Empire Car Coupling Co., of 15 Warren St., New York City. Mr. Geo. P. Conard is President and Mr. Chas. H. Dale is General Agent.

THE FILTER BEDS AT POUGHKEEPSIE, N. Y.

By Chas .E. Fowler, Superintendent Water-Works and Sewers.

The filter beds of the Poughkeepsie water-works were constructed on the European plan, from designs by the late J. P. Kirkwood, as described in the Manual of American Water-Works for 1889-90. They have a capacity of 3,000,000 gallons in 24 hours, and have been in use nearly twenty years.

A wide misapprehension seems to prevail as to their usefulness and efficiency. J. T. Fanning's "Water Supply Engineering," fifth edition, 1887, states that these "Filter-beds are at present used but a portion of the year, subsidence in the main reservoir being sufficient to render the water acceptable to the consumers." It is understood, however, that a later edition modifies this statement somewhat.(a)

The report of the Water Commissioners for the

(a) The latest edition, 1891, states: "The filter-beds during their first few years were used but a portion of the year, subsidence in the main reservoir being sufficient to render the water acceptable to consumers."

year 1874 states: "The use of these beds has been abandoned except as may be occasionally required, when from the stage of the river the water may be unusually turbid. In lieu of filtration, subsidence in the reservoir has been adopted."

In the year 1875 the beds were in use about six months. In the year 1876 they "were in almost constant use." In the report for 1877 it is stated: "The entire supply for city this year was filtered." In the report for 1878 the volume filtered is the entire volume pumped, and it is added: "The consumers accustomed to drink filtered water will accept nothing else, nor will they consider any circumstance, or complication of circumstances, as offering any excuse for their non-use." In the reports for 1879 and 1880 the volumes filtered are the entire volumes pumped.

When the writer assumed charge of the works in the middle of January, 1881, he found the beds not in use owing to need of cleaning rendered difficult by a heavy coating of ice. The ice was at once removed and the beds put in use, and from that time until the present, more than eleven years, no water has been delivered to the city that has not passed through them.

The only chemical analysis, by competent authority, of the unfiltered and filtered water, showing the efficiency of the beds prior to 1889, was made in November, 1877, by the late W. R. Nichols, of the Massachusetts Institute of Technology.

Twelve years later, in November, 1889, Prof. T M. Drown, of the Massachusetts Institute of Technology, made an analysis, and in 1891 still another The last of Prof. Drown's analyses included two samples, but his first analysis and that of Prof. Nichols included but one sample. The results of these three analyses, in parts per 100,000 of albuminoid and free ammonia before and after analysis, percentage of reduction, and percentage of reduction of free ammonia and total solids, are as follows:

	Albuminoid ammonia, parts per 100,000.			Per cent. reduction of.	
Date.	Unfiltered water.	Filtered water.	P. c. reduction.	Free am.	Total solids.
Nov., '77	.0197	.0139	29	30	24
" '89	.0198	.0130	34	68	22
" '91	.0153	.0100	35	100	28

If we regard the reduction of albuminoid ammonia as indicating the proportion of organic matter removed by the filter beds we shall find a material increase of efficiency from 1877 to 1891.

This fact is noteworthy when we consider that the 4 ft. in depth of broken stone, coarse and fine gravel composing the lower portion of these beds has been undisturbed since their construction twenty years ago, and that the sand composing the upper portion has remained unchanged since 1877, save that it has several times been removed, washed and replaced.

In view of these facts we must necessarily conclude that the organic matter removed from the water passing through the materials composing these beds is not again imparted to other water of the same character on its passage through the same material. In other words, whatever organic purification there may be, as the result of filtration, does not diminish with use, but, on the contrary, tends to increase.

An analysis was made by Prof. Drown of three samples collected Feb. 10, 1891, of which No. 1 was from the applied water, and No. 2 from the effluent of one bed the first day after cleaning, and No. 3 from the effluent of the other bed which had been in constant use during a period of eight weeks without cleaning. The results gave albuminoid ammonia, No. 1, .0126 per 100,000; No. 2, .0070; No. 3, .0074, showing a reduction of 44 per cent. the first day after cleaning and a reduction of 41 per cent. after eight weeks' use. The usual period between cleaning is from three to five weeks.

Prof. Drown made bacteriological examinations of the samples submitted in November, 1891, which show, for the first set, 1,160 bacteria per cu. cm. in the applied water and 62 in the effluent, a reduction of 95 per cent.; in the second set 1,576 bacteria per cu. cm. in the applied water and 34 in the effluent, a reduction of 98 per cent. These results appear to vary somewhat with the season. In January, 1892, the reduction of bacteria was but 82 per cent.

Little or no effect is produced on the color of the water, at any time, by filtration.

At certain seasons of the year, usually after the first severe cold of winter and again at the breaking up of winter, a peculiar turbidity is present in the river water which the filter beds will not remove. The usual rate of filtration is 6 ins. in vertical depth per hour. If, at the times referred to, the rate is reduced to 3 ins. in depth per hour, or even less, little or no improvement is effected. This turbidity is caused by finely divided clay, which readily passes through several thicknesses of the finest filter paper.

During one of these periods of clay turbidity a high pressure filter, using alum as a coagulant, was tried, and the result was clear, bright water, but the quantity of alum required was not only very great but an appreciable amount was left in the effluent.

The constant operation of these beds, at all seasons, is an absolute necessity in order to render the water of the Hudson River at this point fit for domestic use, and no effort is spared to maintain them in excellent working condition.

The Anderson process will be given a trial in connection with these beds, in the hope of producing a colorless water and of removing the clay turbidity above mentioned.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

VII.

(These papers will be republished in book form, and corrections or proper additions are solicited, and can be made at any time.)

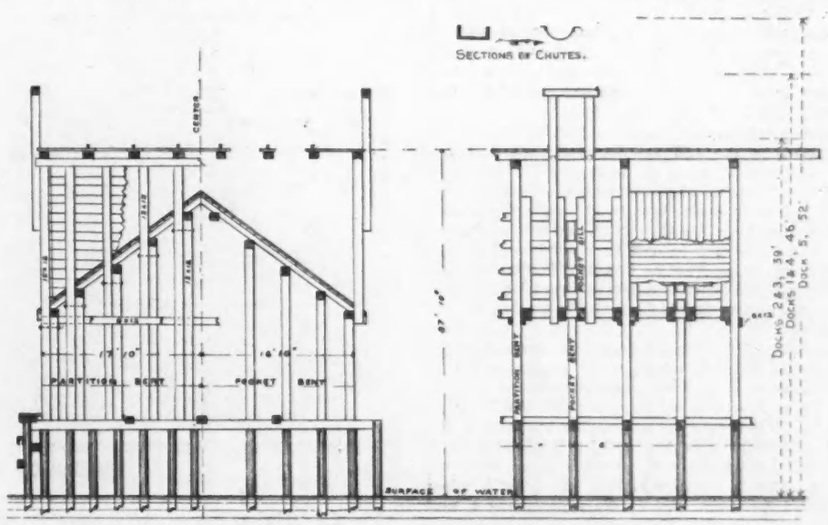
THE EARLY ENGINEERING SCHOOLS FOLLOWING THE R. P. I.

For a period of ten years after the Rensselaer School had been expanded into a true engineering school, in 1835, there was a complete cessation of all efforts to increase the facilities for educating engineers. The Rensselaer Institute was graduating from 6 to 13 men per year with the degree of C. E.; West Point was still contributing a small percentage of its graduates to the ranks of civil engineers, and that was all. The demand for engineers was then not great; they were chiefly self-taught and trained in the field. Two or three old schools which had semi-technical courses, like the Virginia Military Institute, aided a few men to make themselves into civil engineers; but the educational facilities which then existed were felt to be sufficient, if we may judge from the fact that during all this decade no effort seems to have been made to extend those facilities.

During the next two years, however, three different schools, each of which has endured to the present day, were founded. The first was the School of Engineering of Union College, Schenectady, N. Y., founded in 1845, and notable not only as the second engineering school founded in the United States, but as the first ever founded by the enterprise of an existing classical college without any gift from a founder. Union College itself was founded in 1795, and was almost in the center of early engineering activity, the first canal work on this continent and the first railway work of any magnitude having been done in or near to Schenectady. To this fact, perhaps, rather than to any exceptional foresight or breadth of view, was owing its exceptionally early foundation. The school was rather a small affair up to 1860, however, sometimes graduating two or three engineers a year, and sometimes none. The first special degrees in engineering seem to have been given in 1857.

Up to 1855-60, therefore, the school was hardly heard of outside of its immediate vicinity, and only because of the very early date of its first formation does it hold a prominent place among our early engineering schools. Since 1860 the school has graduated every year classes varying from 2 to 14, and averaging nearly 8, but as it has not yet attained a specially prominent place, we have not felt warranted in taking time and space to investigate its early history in more detail.

The third school of engineering to be founded (it has been often said to be the second, but incorrectly) was the Lawrence Scientific School, founded in 1846 as a branch of Harvard University in anticipation of a gift of $50,000 from Hon. Abbott Lawrence, which followed the next year, and was in turn followed by a second gift from him of the same amount a year or two later. The early history of this school for many reasons deserves careful study, which we will give it. Following close upon this school again, almost simultaneously, came the first formation of what is now known as the Sheffield Scientific School of Yale University, which was nominally organized in 1847, but which as a live and active school of engineering dates practically from 1861, at about which time the Lawrence Scientific School (then quite an old and flourishing institution) was getting ready to begin to go into a decline from which it has not yet recovered.



OLD STYLE OF ORE DOCK, ESCANABA, MICH.

After these three schools had been founded, all of them upon a rather precarious foundation, but the Lawrence Scientific School by far the strongest, there was a pause until 1852, when the Engineering Department of the University of Michigan was organized, also without any gift from an individual as an impulse. The university itself had been founded in 1837, and first opened in 1841. The State of Michigan deserves great honor for everything connected with that university, but perhaps for nothing more than for having started the first engineering school in the country which was not the product of private beneficence, and which was also organized from the first on a footing of entire equality with the classical department of the university, and in such manner that by mere expansion and growth, without further radical changes, it

could and did expand into an engineering school of the first class. Its first degrees of C. E. were conferred in 1860. Despite the comparative rawness and poverty of the State prior to 1860, Michigan may be said to have founded in order of time the second vigorous and healthy engineering school in the United States.

After these five schools, which may be called the only early schools, had been founded and were well under way, no sixth appeared until the Brooklyn Polytechnic Institute (founded in 1845) began graduating students in engineering in 1866. All the hundred or more schools which now exist have come into existence since that date, the next important one having been the Columbia College School of Mines.

It will be seen, therefore, that Harvard, Yale and Troy practically had the field all to themselves for some 15 or 20 years after their foundation. The University of Michigan was too far off to affect them. Union College was then too weak and poor, too near Troy, and comparatively too inconspicuous to be a successful early rival. Harvard and Yale alone had such national prestige as to make it a very easy thing for them to found a successful engineering school. They had every advantage for doing so if they were really in earnest about it. They had world wide fame to give prestige to the school from the beginning. They already had fine and large libraries. They already had, or needed to have for their general courses, professors of mathematics, astronomy, physics, chemistry, geology and the like, as well as of belles lettres and necessary English branches, who could give a large part of the instructions needed for courses in engineering without adding professors for that special work. The Rensselaer Institute had no such advantage, but on the contrary did have the advantage of 15 or 20 years' earlier start.

It is interesting and instructive to compare the use made by these three organizations of their several opportunities. They had the field to themselves for nearly twenty years. It is easy after the event, at least, to see that it was an important field. Over 100 schools of engineering have sprung up since the end of this probationary period, which with rare exceptions are still growing and expanding, and likely to continue to do so for many years yet to come, for technical education is still in its infancy. It had taken centuries to build up the classical colleges to where they then stood, and surely if coming events were ever to cast their shadows before, so tremendous an event as was then fast approaching, the sudden creation of a new and vast department of educational work which is visibly tending to overshadow all others, must have cast a sufficient shadow before to enable those controlling great educational trusts to see it, if the general public did not, and to shape their course accordingly.

To what extent did they do this? As for Rensselaer, it is beyond denial that they hid none of their talents under a napkin, and let no chances go by them. Drawbacks and mistakes there were and have been in its management. Every such school must have them. But in the main it has a most honorable record, both as to the quantity and the quality of its instruction, as will appear more fully later, when we reach the tabulations of number of graduates and of curriculums.

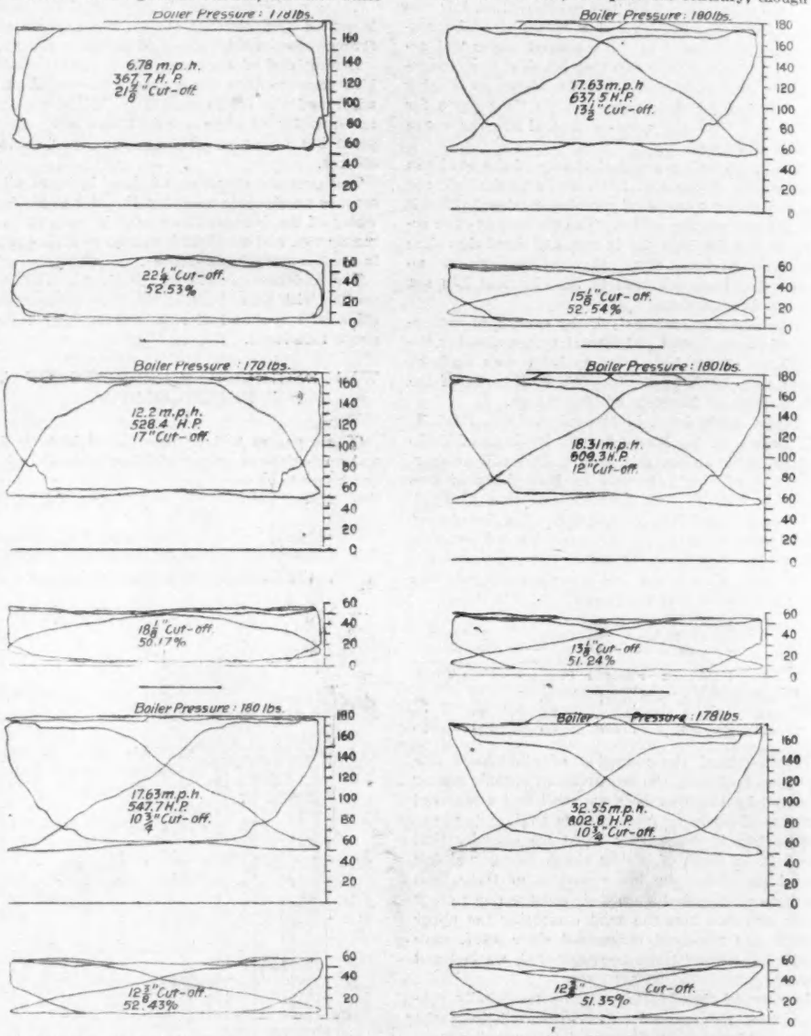
As for Yale, it did not really have the opportunities as an early engineering school which would appear from its date of nominal foundation. The Sheffield Scientific School was not really founded until 1861. For several years after its nominal foundation in 1847, up to 1852, instruction in chemistry was given, in a small building belonging to the college, by Profs. Benjamin Silliman and John P. Norton, but there were no graduates even in chemistry until 1852, in which year also the engineering department proper was first started, under Prof. Wm. A. Norton. The school then had a highly precarious existence, funds for it being pretty scarce, until 1859, so that as an engineering school it struggled along on very short commons for seven years.

In that year Mr. Joseph E. Sheffield, a wealthy and enlightened resident of New Haven, became interested (or first showed his interest) in the school. He bought the building which (after additions and changes) was called Sheffield Hall, into which the above mentioned departments moved. In 1861 these separate departments were united under the name of the "Sheffield Scientific School," and there was also established (chiefly by gift from Mr. Sheffield, we believe) a permanent fund for maintaining the school. In this year also entrance examinations were held for the first time. Without them, of course, no school can be of a very high grade. In 1863 two additional courses were begun, the "select" course providing a general education in the English studies and in general science, but not otherwise of a technical nature, and a course in agriculture. In 1866 a course in natural history was added.

North Sheffield Hall was not built till 1872. It was built by Mr. Sheffield at a cost of $100,000, and altogether, including some large gifts in 1889, the school has received considerably over $1,000,000 from him and his estate, while by the Fayerweather will (to finish up this record before leaving it) Yale receives $450,000, one-third of which is to be devoted to the Sheffield Scientific School.

Considering that the school did not really get a start until 1861, and hence has only a nominal place in the list of very early schools, and considering also facts yet to be presented in regard to its present standing in attendance and otherwise, this must be admitted to be a fairly good and creditable record. The university did what it felt it could to establish a scientific school, of its own motion and from its own funds, long before it had any reason to expect (or at any rate before it received) any aid from individual gifts. Some highly creditable work in the chemical line, at least, was done in it before it received such aid. We may reasonably believe that it was these efforts which inspired the remarkably generous gifts of Mr. Sheffield, for he was not a childless man, as so many such givers are, nor was he a specially wealthy man, by the standard of 1892. After he began to put the school in funds it has gone on steadily expanding in its work to the present day.

The story of the Lawrence Scientific School is different in many ways. We must tell it in a separate article. It is by no means a story of glorious success, but quite the contrary, though it also has its bright side. But unless we greatly mistake, it is worth telling with some care, as one profitable for doctrine, for reproof, for correction, and for instruction in educational righteousness. "By others' faults wise men correct their own," and as an example of the noble art How not to do it, it is perhaps without a parallel.



INDICATOR DIAGRAMS FROM TWO-CYLINDER COMPOUND MOGUL FREIGHT LOCOMOTIVE; ADIRONDACK & ST. LAWRENCE RY.

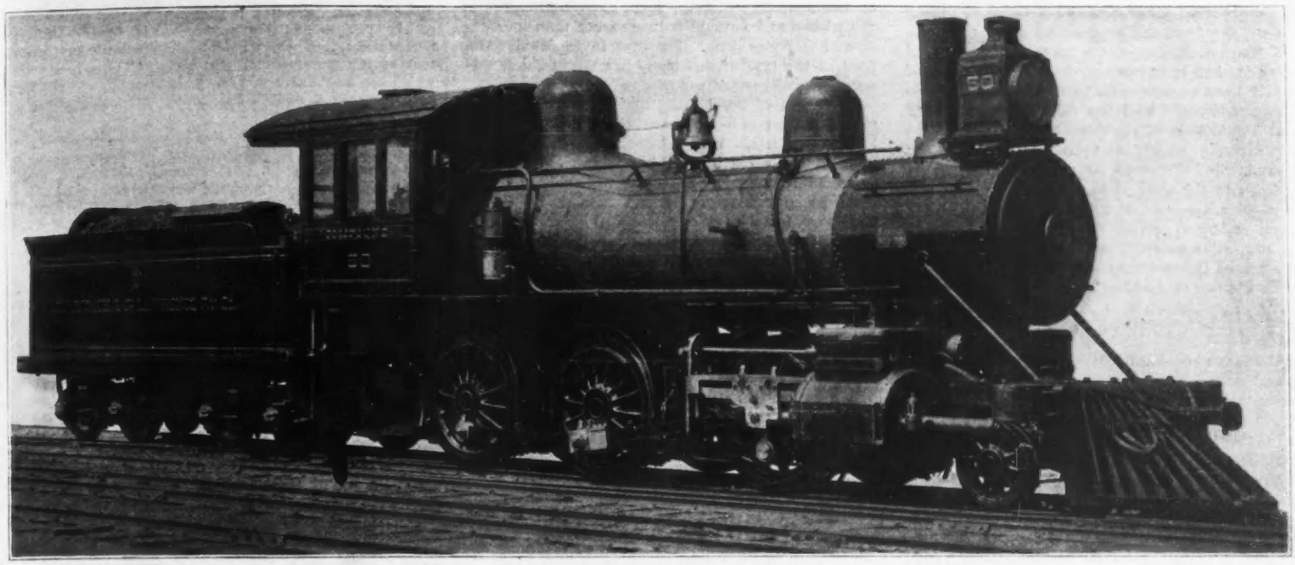
TWO-CYLINDER COMPOUND LOCOMOTIVES.

In our issue of March 8, 1890, we described and illustrated one of the first compound locomotives built in this country, being a ten-wheel passenger engine, on the two-cylinder compound system, built for the Michigan Central R. R. by the Schenectady Locomotive Works, of Schenectady, N. Y. Since then a large number of compound engines on the same system have been built at these works, the builders considering the two-cylinder system the most satisfactory, and using an intercepting valve invented and patented by Mr. A. J. Pitkin, superintendent of the works. The engines built have been of different types, for both passenger and freight service, and some of them have been noted from time to time in our columns. We give herewith six indicator diagrams taken from one of the three new

compound mogul freight engines for the Adirondack & St. Lawrence Ry. The cards were taken while the engine was drawing 55 loaded freight cars on the New York Central & Hudson River R. R. The diagrams are certainly very good specimens, and the builders think them as fine as any they have seen from any compound locomotive. They were taken with the throttle full open in every case. The engine steamed freely with an exhaust nozzle 5 ins. diameter. These engines have the Laird guides, and the piston rods are carried through the back cylinder heads. We also give a view from a photograph of the engine from which the diagrams were taken. The principal particulars of these engines are as follows:

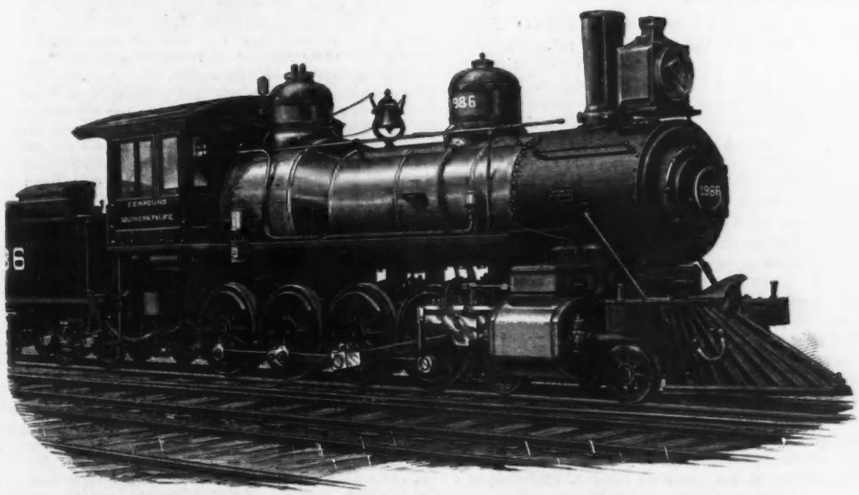
Cylinders, h. p.	20x26 ins.
" l. p.	30 3-16x26 "
Valves, travel	6½ "
" outside lap	1⅛ "
Inside clearance, h. p.	5-16 "
" " l. p.	3-16 "
Driving wheels, diameter	4 ft. 9 ins.
Boiler, form	Wagon top
" diameter at first ring	4 ft. 10 ins.
Working boiler pressure	180 lbs.
Firebox	8 ft. 6 ins. x 3 ft. 6½ ins.
Tubes, number	268
" diameter	2 ins.
" length	11 ft. 6 ins.
Journals, driving	8x9 ins.
" truck	6x10 "
" tender	4½x8 "
Weight on driving wheels	114,500 lbs.
" on truck	18,000 "
" total	132,500 "
Capacity of tank	4,000 gallons
" of fuel space	8 tons

The Schenectady Locomotive Works have also an order for 7 ten-wheel and 20 twelve-wheel engines for the Southern Pacific Ry. All of these will be two-cylinder compound engines, similar to other engines already built for the same road. The boilers are of the wagon-top pattern, with wide and shallow fireboxes. The fuel will be bituminous coal. The brake fittings are the American driver brake.



TWO-CYLINDER COMPOUND MOGUL FREIGHT LOCOMOTIVE ADIRONDACK & ST LAWRENCE RY.

Schenectady Locomotive Works, Builders.

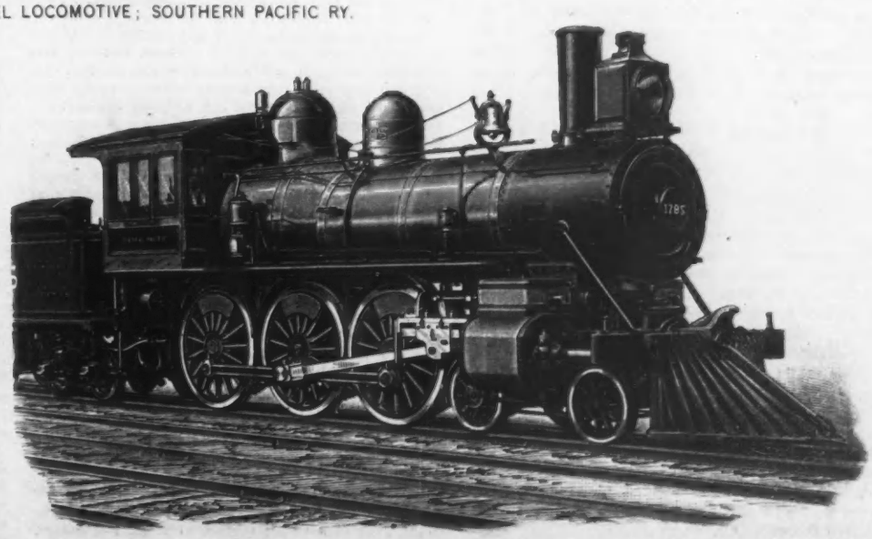


TWO-CYLINDER COMPOUND TWELVE-WHEEL LOCOMOTIVE; SOUTHERN PACIFIC RY.

equalized on all driving wheels, operated by air, and the Westinghouse automatic air brake on tender and for train. The leading dimensions and particulars of these engines are as follows:

Compound Locomotives; Southern Pacific Ry.

	Ten-wheel.	Twelve-wheel.
Cylinders, h. p.	20x26 ins.	20x26 ins.
" l. p.	29x26 ins.	29x26 ins.
" ratio	2.1 to 1	2.1 to 1
Diam. of driving wheels	5 ft. 9 ins.	4 ft. 3 ins.
" truck wheels	2 ft. 9 ins.	2 ft. 2 ins.
" boiler barrel	4 ft. 10 ins.	5 ft. 0 ins.
Firebox, length	8 ft. 0 3-16 ins.	8 ft. 8 3-16 ins.
" width	3 ft. 6¾ ins.	3 ft. 6¾ ins.
" depth, front	4 ft. 11¼ ins.	5 ft. 1¼ ins.
" depth, back	4 ft. 8¼ ins.	4 ft. 10¼ ins.
Boiler pressure	180 lbs.	180 lbs.
Tubes, number	247	270
" dia. outside	2 ins.	2 ins.
" length	12 ft. 6 ins.	12 ft. 8 ins.
Heating surface; tubes	1,604.5 sq. ft.	1,778.33 sq. ft.
" " firebox	137.1 sq. ft.	150.13 sq. ft.
" " total	1,741.6 sq. ft.	1,935.06 sq. ft.
Grate area	28.5 sq. ft.	31.00 sq. ft.
Wheel base, driving	12 ft. 2 ins.	13 ft. 9 ins.
" " rigid	6 ft. 3 ins.	9 ft. 2 ins.
" " truck	6 ft. 0 ins.	6 ft. 0 ins.
" " total	22 ft. 8 ins.	23 ft. 7 ins.
Weight on driv'g wheels	99,500 lbs.	116,800 lbs.
" on truck	30,800 lbs.	22,000 lbs.
" total	130,300 lbs.	138,800 lbs.
Capacity of tank	4,000 gallons.	4,000 gallons.
" of coal space	8 tons.	8 tons.



TWO-CYLINDER COMPOUND TEN-WHEEL LOCOMOTIVE; SOUTHERN PACIFIC RY.

TRAINSHED FOR THE NEW UNION PASSENGER STATION, ST. LOUIS, MO.

(With inset.)

We complete our articles upon this interesting work with the drawings showing details of the longitudinal wind bracing at the front of the trainshed, and the front and rear elevations of the trainshed. The peculiarity of the arrangement of wind bracing is that it consists entirely of a system of diagonal bracing between the two sets of trusses next the front end and the columns which carry them. The details of construction are fully shown by the drawings on our inset sheet. The ends of the trainshed will be covered by glass and corrugated iron down to the level of the tops of the columns, with a clear headway of openings of 20 ft. at the columns and 28 ft. at the middle, as shown by the elevations. The previous articles on this structure are contained in our issues of April 2 and 21. Mr. Geo. H. Pegram is the Consulting Engineer.

STANDARD SPECIFICATIONS FOR M. C. B. COUPLERS.

At the last annual convention of the Master Car Builders' Association a committee was appointed to consider "whether there are any further standards or limits or any change desirable in the M. C. B. type of coupler." The committee is composed of Messrs. Jno. S. Lentz, J. M. Wallis and G. W. Rhodes, and it recently issued a circular to M. C. B. coupler manufacturers outlining its opinions on the matter of standards. The committee requires the use of the Pratt & Whitney gages designed by the executive committee for the determination of the contour lines. For other dimensions of the coupler, the standards of length, thickness and other dimensions adopted by the M. C. B. Association and shown in the announcement of Aug. 1, 1891, must be closely followed. For fastening the tail of the coupler the committee favors the yoke rather than the tail bolt. The committee proposes the following specifications for M. C. B. couplers:

1. Drawbars, including knuckles and locking attachments, should weigh 210 lbs. or less; they must not weigh over 220 lbs.

2. All drop tests will be made on a solid masonry foundation. The knuckle of the bar to be tested will be in its closed (locked) position. The bottom of the drop will be flat, so as to represent the blow from an opposing closed M. C. B. drawbar.

3. Drawbars must be constructed so that when subjected to a pulling test they will stand not less than 100,000 lbs. (In view of the rebound which draft rigging is subjected to after an emergency application of brakes, the committee will consider increasing this limit to 110,000 lbs.)

4. Drawbars should stand the following drop test: Weight of drop, 1,640 lbs.; three blows at 10 ft., two blows at 15 ft. The drawbar or kunckle must break into two or more pieces before it is considered to have failed under this test. The cracking of the parts will not be considered as a failure.

5. In subjecting bars to tests 3 and 4, the drawbars and knuckles will be considered separately, viz.: A failure of one will not condemn the other.

A meeting was held by the committee at Pittsburg, Pa., on April 26, for the discussion of the above provisional specifications. All couplers were represented, and the only change made was to increase the pulling test to 125,000 lbs.

THE RAPIDITY OF FIRE IN MACHINE GUNS.

The rapidity of fire with a single-barreled machine gun forms the subject of a letter of Mr. H. S. Maxim to "Engineering." This letter is brought out by a news item, stating that a gun made by the Winchesters "fires 1,000 rounds a minute and beats the Maxim gun with its 750 rounds per minute." Mr. Maxim says his first gun officially tested at Enfield discharged 1,000 cartridges in 1 1-2 minutes, or 666 per minute. This was with the Royal Woolwich cartridges, the most perfect then made. In another trial in Switzerland, with German Mauser cartridges, the rate of fire was 612 per minute. With the new Austrian cartridge with compressed powder, a speed of 770 shots per minute was attained. The highest rate of fire ever reached by an automatic gun, deriving all its energy from the recoil, was 775 shots per minute, made with cartridges made in the United States by the Union Metallic Cartridge Co.

About two years ago Mr. Maxim constructed a gun to utilize the force of the escaping gases at the muzzle to operate the mechanism. With the French Label cartridges a speed of 1,100 to 1,200 shots per minute was attained with this gun. But both French and German officers decided that the rate of fire was altogether too high, and they expressed the wish that he would reduce rather than increase it, and this was done. The first 1-pdr. Maxim gun fired at the rate of 400 shots per minute, and this speed was afterward reduced to 300 shots.

The effect of rapid firing upon the chamber and rifling of the gun is most marked, says Mr. Maxim. In Austrian trials, with a 600-shot per minute rate, with steel covered bullets, but with frequent stoppages to replace the ammunition boxes, the gun made as good a target after 20,000 rounds as at starting. But with a speed of 670 shots per minute and practically no stopping, the bore was considerably injured after 10,000 rounds.

Mr. Maxim thinks that with a single-barrel gun, with both gun and cartridge made expressly for the maximum speed, and utilizing both the recoil energy and the escaping force of the gas, a speed of 1,500 to 1,600 shots per minute might be attained. But at this rate the barrel would be very highly heated, even if inclosed in a water casing.

The greatest absolute speed of fire yet attained with machine guns operated by hand and with more than one barrel, is given as follows: With the 12-barrel Nordenfeldt, each barrel 100 rounds per minute; the Gatling 10-barrel, 100 rounds per barrel per minute; 5 barrel Nordenfeldt, with three trained operators, 400 to 500 rounds in all; 2-barreled Gardner, with four men, 333 rounds per minute. Mr. Maxim has fired a 3-pdr., with cartridges 21 ins. long, at the rate of 40 rounds in 50 seconds, which is the best record he knows of for heavier guns with only one man attending.

BALANCING MARINE ENGINES AND THE VIBRATION OF VESSELS.

At the 1891 annual meeting of the Institution of Naval Architects of Great Britain, Mr. A. F. Yarrow, the famous torpedo boat builder, read a paper on the construction of boilers for forced draft, which was by all odds the most important of the papers submitted at the meeting, and was one of the most valuable ever published on that subject. We published the substance of this paper in our issues of April 11 and 18, 1891. At the meeting of the Institution held in the early part of this month Mr. Yarrow presented a paper with the title given above, which, to those interested in the problem of high speed in steam vessels, is almost or quite as valuable as the paper read by him a year ago.

The vibration of some screw-propelled vessels is sometimes in excess even of that caused by paddle-wheels. The cause of vibration is generally believed to be the propeller, but Mr. Yarrow showed by exhaustive experiments that, while an unbalanced propeller may cause vibration, a more important cause is the unbalanced action of the engines. We reprint the substance of his paper as follows, reproducing most of the illustrations from "Engineering:"

All who are acquainted with the working of steamers provided with large power and of high speed, such as torpedo boats, torpedo boat catchers, and very fast passenger steamers, will be familiar with the fact that they are subject to considerable vibration under some conditions, especially since the adoption of steel for shipbuilding and high piston speed. To overcome it is daily becoming a matter of increasing importance, as higher and higher speeds are being continually demanded. It is to a study of the laws which govern this vibration and to the possibility of avoiding it that I invite your attention.

I will first describe some experiments which we have carried out during the last few years, with a view to throw light upon this subject. At the outset we felt the want of some means of accurately indicating and recording the extent and character of vibration and therefore devised an instrument for the purpose. This instrument has been in use for the last six years, and is, I believe, reliable. It consists, as shown in Fig. 1, of a heavily weighted drum suspended by elastic connections. This drum is provided with a suitable clockwork to cause it to revolve, and is regulated to make one revolution per minute. Attached to an upright, fixed to the stand of the machine, is a pencil, which presses lightly against the drum, round which a sheet of paper is wrapped, in the same manner as in an ordinary indicator. It will be readily understood that if the base of this instrument be placed upon a platform, or the deck of a vessel subject to vertical vibration, this movement will be transmitted to the whole apparatus, excepting that portion which is suspended by the elastic connection, and this being heavily weighted will not follow the vibratory motion of the stand. Now if we place our instrument on the stern or any part of a steamer which is vibrating and start the drum revolving, the pencil being pressed against the paper makes a line, indicating the relative vertical positions of the pencils and the paper, or, in other words, makes a diagram which records the character and extent of the movement of that part of the ship upon which the instrument stands. This instrument we call a "vibrometer," and it has mainly been devised by my friend Mr. Nesbitt.

I believe the cause of vibration in screw vessels, when running in smooth water with their propellers well immersed, to be mainly due to the forces produced by the unbalanced moving parts of the machinery, such as the pistons, piston rods, valves, gear, etc., excepting when it is the result of bad workmanship or bad state of repair. For example, as clearly pointed out by Mr. Barnaby in his treatise on marine propellers, vibration may be set up by a screw, the center of gravity of which is out of the center line of the shaft, or it may be due to want of uniformity in the position, area, or shape of the blades; these causes being avoidable by proper care, I do not propose to deal with them. I would, however, take this opportunity to observe that sufficient attention is not always paid to these points.

From our experiments we have overwhelming proof that the vibration in a torpedo boat is precisely the same in extent and character when the screw is on and the vessel driven through by it the water, as it is when the boat is stationary and the engines simply revolving without doing work, the propeller being removed. To prove that this statement is correct I would beg your reference to Fig. 2, upon which are shown enlarged vibrometer diagrams, which have been obtained from torpedo boats when running and when stationary. These diagrams represent a fair average of over a hundred results. It will be seen that diagrams A and A1 are practically alike; also diagrams B and B1; and diagrams C and C1, A, B, and C having been obtained when the boat was under way with propeller on, and A1, B1, and C1, when the vessel was stationary, being without propeller. The engines were making exactly the same number of revolutions in each corresponding pair of diagrams. Not only do these diagrams prove that the screw had nothing to do with the vibration, and that it was owing to the working of the machinery, but it will be seen how greatly our investigation is facilitated by these facts, because experiments can be carried out with a boat at rest, and we know that the same results as regards vibration will be found under ordinary working conditions.

It is a well known fact that engines will impart their vibration to a boat at certain speeds much more readily than at other speeds, and it often happens that at full speed a boat may be practically steady, while at a slower speed the vibration is excessive. This is dependent upon the extent to which the movements of the reciprocating parts of the engine correspond with the period of vibration of the hull, which may be considered in this investigation as an elastic body. This is illustrated by the well known fact that when soldiers are crossing a suspension bridge it is often found necessary to avoid their marching in step. Some years since we had a boat in which severe vibration occurred at 200, 400, 600 and 800 revolutions per minute, but there was none at the intermediate speeds of 300, 500 and 700. The diagrams in Fig. 3 show very clearly how the vibration varies at different speeds, and the variation that takes place in the extent of the vibration when passing from one speed to another.

In a vessel, such as a fast Atlantic liner, which is intended to run continuously at a nearly uniform speed (unless special means be taken to balance the machinery), it is of the utmost importance to carefully avoid the number of revolutions of the engines per minute synchronising with the normal vibration of the hull. This cannot be carried out in the case of war ships and others which are intended to run at varying speeds; for if the speed of the engines be proportioned so as not to set up vibration at full speed, they will probably do so at intermediate or cruising speeds; and if they set up no vibration at cruising speeds, they will probably vibrate at full speed. I believe it would be by no means a difficult matter to determine in the original design, with fair accuracy, what speed of engine would be suitable to avoid vibration being set up in any given design of hull. We frequently hear of propellers being changed in order to reduce vibration, and in many cases the change is made with advantage; but it often happens that the improvement is not directly due to the altered shape of the propeller, but indirectly to the change causing an alteration in the number of revolutions of the engine, and thereby preventing their synchronising with natural vibrations of the ship. We hear of hulls being strengthened or built stronger than would otherwise be necessary with a view to reduce vibration. Doubtless this is done with more or less success, due, possibly, not so much to the greater

strength of hull, but rather to the period of vibration being modified by this stiffening so as to avoid its harmonizing with the movements of the machinery. Building vessels of greater strength than would otherwise be necessary, with the object of avoiding vibration, cannot be considered a scientific method of dealing with the difficulty, if it can be proved that vibration can be avoided by other means and without extra weight; be-

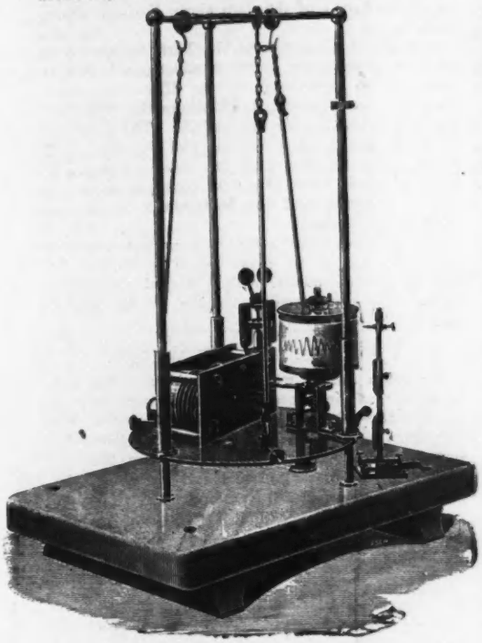


Fig. 1.

cause extra weight of material added to the ship tends to handicap its speed. The true cause of vibration being due to the machinery, I think it will be admitted that the correct mode of dealing with it is to so design the engines that they may be steady within themselves and free from any tendency to cause the hull to vibrate. As a further proof that the vibration is due to the machinery,, I may mention that two years ago I made a passage to the United States in one of the very fast twin-screw steamers. I selected a berth in the central portion of the vessel, thinking it a good position for comfort, but the vibration was found to be so excessive that after five days it was scarcely bearable to those passengers whose berths, like my own, were situated at the points of greatest vibration. The vibration was found to vary periodically. When the two low pressure pistons were descending at the same time it was excessive; but when one low pressure piston was ascending and the other descending it was entirely neutralized. So distinct was the vibration in my cabin that it was quite easy to count the number of revolutions of the port and starboard engines, and we rigged up a temporary vibrometer on our cabin side, which gave us diagrams, indicating clearly the movements we were subject to. I believe all who have studied the subject of vibration in steamers will agree with me that many vessels which vibrate considerably are in consequence credited with weakness, while in reality they are of ample strength, the fault resting entirely with the engines and not with the hull. Not only is this vibration a source of discomfort to passengers but it clearly adds considerably to the wear and tear of the vessel.

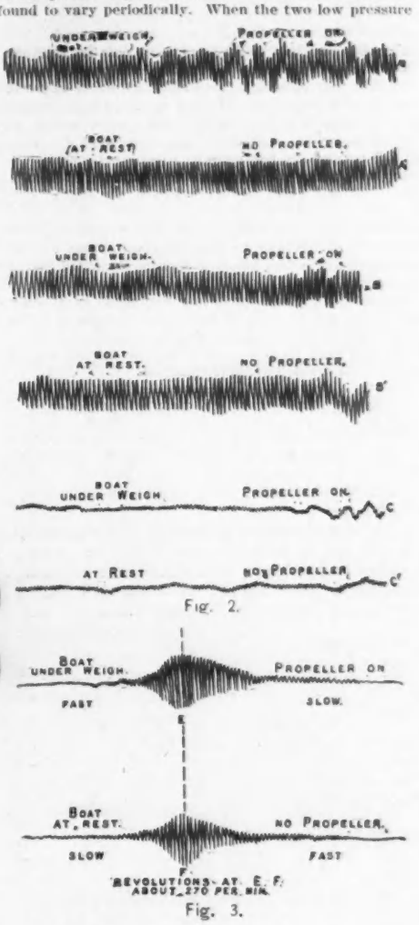


Fig. 2.

Fig. 3.

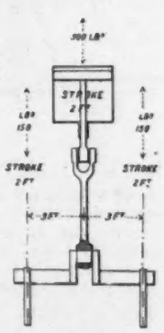


Fig. 4.

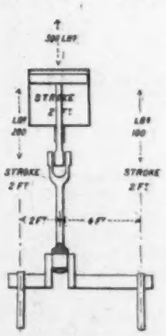


Fig. 5.

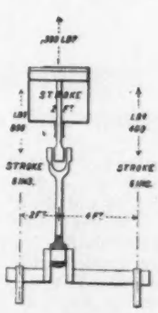


Fig. 6.

Fig. 10.

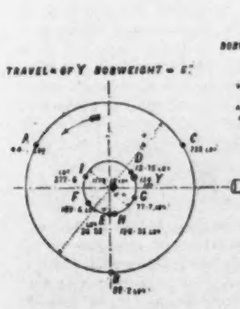


Fig. 7.

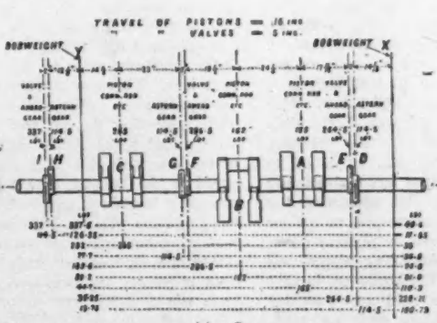


Fig. 8.

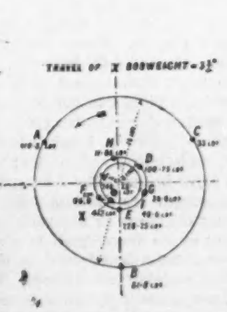


Fig. 9.

Let us consider exactly why an engine produces vibration. In an ordinary inverted engine the steam presses on the cylinder cover and on the piston, and from the piston the stress is transmitted to the bedplate. Now during the first half of the down stroke the upward pressure on the cylinder cover is greater than the downward pressure on the bedplate to the extent of what is needed to set the reciprocating parts in motion, and this excess of upward over downward pressure lifts the engine bed and that portion of the hull to which it is attached. By a like train of reasoning it can be shown that during the latter half of the down stroke and the first half of the up stroke the tendency is to lower the engine bed; also that during the second half of the up stroke the tendency is to raise the engine bed. To sum this up in a few words, during the upper half of the revolution the engine tends to lift the vessel and during the lower half to depress it. The main principle which governs the whole matter may be thus summed up. As no internal force can move the center of gravity of a body it follows that any momentum generated by steam pressure in the moving parts, such as the piston, etc., must be attended by an exactly equal momentum in the rest of the ship in the opposite direction.

We will now pass on to consider how to design engines so that they may be perfectly free from vibration. For this purpose please refer to Fig. 4, representing a single cylinder inverted engine, which for the sake of simplicity we will assume has no valve gear. The revolving parts, such as the crank, crank-pin, and a portion of the connecting-rod can be balanced by means of rotary weights in the usual way and we then have only the vertical unbalanced parts, such as the piston, piston-rod, etc., left to deal with. Now if we have two eccentrics set opposite to the crank, at equal distances from it, and of equal stroke to it, and these impart an up-and-down motion to weights which we will call "bob weights," each of which is half as heavy as the parts to be balanced, that piece of mechanism will revolve free from vibration, excepting that which is due to the angle of the connecting rods. If we wish to place these weights at unequal distances from the crank (see Fig. 5), they must be proportioned to vary in weight inversely as their distances from the crank, that is, if one weight be twice as far from the center of the crank it will have to be half the weight of the other, the sum of the weights in this case being the same irrespective of their position. If we desire to reduce the stroke of these weights so as to obtain a convenient length of stroke (see Fig. 6) we shall then have to increase their weight inversely as the stroke, that is, if we quarter the stroke the weights will have to be quadrupled, and so forth. It will thus be seen to be a simple matter to proportion the bob weights, their stroke and their position to suit what may best work in with any design of engine.

To sum up in a few words what must be done to avoid the effect of the momentum generated by the working parts being felt by the hull, an equal momentum in an opposite direction should be produced.

If instead of using bob weights rotary weights of equal amount had been employed, having their centers of gravity in the same position as the centers of the eccentrics which give motion to the bob weights, the engine would still be balanced vertically but would be unbalanced horizontally.

I would now direct your attention to Figs. 7 to 9, showing the calculation as applied to triple expansion vertical engines. The most suitable positions are first determined for fixing the two eccentrics which give motion to the bob weights, in this case the one lettered X being at the forward end of the engines and the other lettered Y being between the low pressure crank and its valve eccentrics. Each unbalanced moving part in the engine is then dealt with separately, as before described, and the position and amount of the weights necessary to balance it ascertained, the stroke of the balance weights being taken, for the purposes of calculation, as equal to the stroke of the part they balance in each case. For instance, take the middle pressure piston, piston rod, etc., lettered B, the unbalanced reciprocating parts of which weigh 162 lbs. the balance required at X is found to be 81.8 lbs. and at Y 80.2 lbs., the stroke of each being 16 ins.. Taking another instance, for example, the high pressure valve and its go-ahead gear, lettered E, weighing 264.5 lbs., the balance at X is found to be 228.25 lbs., and at Y 26.25 lbs.,the stroke of each being 5 ins. After dealing in a similar manner with all the reciprocating parts, if we

were to construct two uniform disks with each of the weights thus found pinned on its proper relative position, and place them respectively at X and Y, the engine would be balanced vertically. All the weights at X might be replaced by one large weight equal to the sum of the weights and having the same position of center of gravity, in a like manner the weights at Y may be dealt with. These are shown by the large black spots on the diagrams. These again might be replaced by larger or smaller weights, as convenient, situated nearer to or further from the center of the shaft, the amount of weight being in the inverse ratio to the distance from the center. It will be seen that in the present case the total weight of all the balances equaled 740.25 lbs. at X, and 1,178.15 lbs. at Y and the distance of their center of gravity from center of shaft was 1.04 ins., and .28 in. respectively; these would be equivalent to a rotary weight of 413 lbs. at X, with its center of gravity 1⅛ ins. from the center of the shaft, and a rotary weight of 134 lbs. at Y, with its center of gravity 2½ ins. from the center of the shaft, these two weights would balance the engine vertically, but would set up side vibration. To avoid the latter and to retain only the vertical effect, the use of bob weights equal to the rotary weights, and having the same vertical motion, and in the same relative position on the shaft, are substituted. This method was adopted in the engines we shall refer to later on.

The correctness of this mode of calculation is confirmed by experience in practical working. The exact amount, position and stroke of the bob weights can be accurately calculated in the original design and if they be made accordingly, no vibration will take place at any speed. The calculations are simple, but care must be taken that they are based on accurate data. To estimate the weights of the reciprocating parts from drawings is not sufficient; they should be ascertained by actually weighing the finished articles.

Triple expansion engines with three cranks, although partially balanced when at rest, are very far from balanced when at work, owing to the distance between the various reciprocating parts, which consequently set up a rocking motion which is the principal one to be overcome, and in such engines this rocking motion we have to deal with in addition to the vertical motion of the center of gravity, this vertical motion being due to the difference in weight of the working parts of the three engines. The position of the bob weights should be chosen so as to minimize their weight. What weight may be necessary to avoid vertical vibration of the center of gravity is constant, but what may be required to avoid rocking motion is diminished by an increased distance apart of the weights. In double cylinder engines with cranks at right angles it is a more pronounced galloping motion, i. e., a motion of a complex kind, being a compound of vertical motions of their center of gravity and a rocking motion. In a single cylinder engine the vibration of the engine is practically up and down. But with whatever type of motion we have to deal, the same principle of balancing holds good. All forces causing vertical vibration can be neutralized by the use of bob weights, arranged to set up equal forces acting in an opposite direction. Some years ago we thought the vibration in triple expansion engines was due to the difference in weight of the pistons; and with a view to balance them, and, as we supposed, avoid vibration, we made each piston of the same weight in a first-class torpedo boat; thus we prevented any vertical movements of the center of gravity of the engines, yet we found no improvement. This clearly indicates that the rocking vibration are of more importance than the vertical vibrations in triple expansion engines.

There is one feature about the vibration of vessels which deserves attention, viz., that it varies in intensity at different points in the length of the hull; there are places where it is excessive and places, termed nodes, where it does not exist.

As an instance of the actual application of the method above outlined, a first-class torpedo boat 130 ft. long and 13 ft. 6 ins. beam was fitted with engines indicating about 1,100 HP., designed to drive the boat at 22 to 23 knots with a load of 20 tons. Two eccentrics were fixed on the shaft at each end, working vertical bob weights.

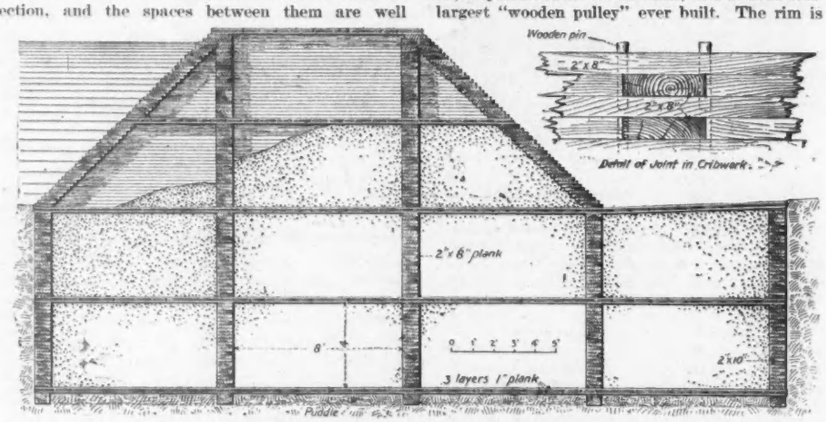
To the cranks were fitted weights sufficient to balance them, the crank pins, and partially the connecting rods. How far each connecting rod was balanced by rotary weights was determined by its weight and the lateral movement of its center of gravity; what remained unbalanced was balanced by the bob weights worked by the eccentrics, their stroke and weight being calculated as already explained when describing Figs. 7 to 9. Experiments were tried with this boat under three conditions, (1) without any balance weights whatever, as engines are usually constructed, (2) with balance weights on the cranks only, and (3) with balance weights on cranks and bob weights. The amount of vertical vibration at the stern, as obtained in the river, is given in Fig. 8, together with the enlarged vibrometer diagrams, from which it will be seen that the results corresponding to the three conditions show a vibration of 27-64 in. as usually made, 20-64 in. with balance weights on cranks, and 7-64 in. with balance on cranks and bob weights. I have not the slightest doubt, from more recent experience, that this small vibration that remained could still further be reduced, and in fact practically avoided altogether, by taking greater care in accurately ascertaining the weight of all moving parts. The foregoing trials were all made at 248 revolutions per minute, which corresponded in this boat to the speed producing maximum vibration, that is to say when the movement of the engine synchronized to the greatest extent with that of the boat. I believe that the vibration of the largest Atlantic liner can in this way be practically overcome by the expenditure of a few hundred pounds, if carried out in the original design.

Bob weights proportioned and arranged as already described, may be reduced in amount if wished, being substituted by a rotary balance weight equal to such reduction; this, however, must not be carried out to an extent to produce sensible vibration.

THE KIRK TYPE OF WOODEN DAM.

Mr. Arthur Kirk, of Pittsburg, Pa., has patented a design for a "stationary dam," made of planks and timbers, as illustrated herewith. The method of construction is described as follows by the inventor:

After the foundation is properly prepared, mudsills are laid at 8-ft. intervals across the stream or at right angles to its axis. These sills are made of sawed or hewn timber, are about 6x8 ins. in section, and the spaces between them are well puddled and hand-rammed to the level of the top of the sills. On these sills is then laid a close floor of 1-in. boards 16 ft. long, running up and down stream. A second floor of the same boards is next laid across the first, and a third floor in the line of the first. Auger holes are then bored through the three floors and into the mudsills, and dry wooden pins are used in binding the whole together.



A PROPOSED WOODEN DAM; Arthur Kirk, Engineer.

On this bottom floor strings of 2x10 in. plank are laid along the upper and lower edge of the floor, and 2x8-in. plank between, with 8 ft. between centers. These are crossed with 2x8 in. plank, also at 8-ft. intervals, and as soon as the crib work thus formed is 8 or 10 ins. high it is bored and pinned to the floor and sills below. This is continued until the crib is about 4 ft. high. Care is taken to break joints at every crossing, and each crib layer of 8 or 10 ins. is pinned to the layer below. The 2-in. spaces left between the crib-corners are filled in solid with planks of the proper thickness as the work progresses, and these filling pieces are secured in place by pinning down through holes bored half in the filling pieces and half in crossing crib timbers. The boxes are in this manner made tight enough to hold any material most convenient for filling them, such as sand, gravel or silt. All the planks used should be single surfaced.

Having filled with the best available ballast this first 4 ft. of the cribwork level with the top, another floor of three thicknesses of inch board is laid over it, as first described, and 4 ft. more of like crib-work is built upon this floor and filled with ballast. This process is continued until the desired height is reached. The dam can be given any shape, and can be sloped on one side only, or on both sides, as deemed best. As a rule, the base should be nearly double the height, but if the foundation is anything but solid rock the cribwork should be extended on the discharge side, as shown in the illustration. The length of this apron should about equal the height of the dam above the bed of the stream.

The claims advanced by Mr. Kirk for this type of dam construction may be summarized as follows: It is cheap and strong. The intervening floors are heavy enough to distribute the weight of the ballast evenly over the mudsills. The structure is firmly tied in all directions, and the upper and lower faces of the dam are made strong and tight by 10-in. walls of plank, braced at intervals of 4 ft. vertically and 8 ft. horizontally by the crib timbers and floors.

The inventor believes that this system could be efficiently applied to ocean beach protection, by building it in sections, with V-shaped projections fitting into corresponding notches in the section added.

A WOODEN RIM FLY WHEEL.

A wooden rim fly wheel, 30 ft. in diameter, has been built at the Amoskeag Mills, Manchester, N. H., to replace the cast iron wheel which burst with disastrous results last fall. The new wheel was designed by Mr. Chas. H. Manning, M. Am. Soc. M. E., Superintendent of the mills, and is doubtless the largest "wooden pulley" ever built. The rim is 12 ins. thick and 108¼ ins. broad. It is made up of pieces of ash, 7 ft. 10 ins. long, 12 ins. wide and 2⅜ ins. thick. These were planed and sawed to the curve of the rim. To make the rim, 12 of these pieces were placed end to end to form one complete ring and the next ring was joined to it by glue and lag bolts, the sections breaking joints with those of the first ring. About 20,000 ft. of ash lumber and 18,000 4x7-16 in. lag screws, 16 to each section, were used in making the rim. To give additional strength, every 7 ft. around the rim there are four ⅞-in. bolts which pass entirely through the rim from side to side.

The hub and arms of the wheel are built up of cast iron. There are two complete sets, each set having 12 arms. The arms are of tubular section, with projecting flanges and abut against the rim with a flat plate 20x24 ins. This plate is bolted to the rim with eight 1-in. bolts. Each arm is secured to the hub by four 1¾-in. bolts. The hubs are made in halves, and bolted together. The total weight of the wheel is 104,000 lbs. It will be noted that the construction of the wheel on this plan obviated the expense and trouble which would have been necessary in transporting a cast iron wheel from the foundry and getting it into place. The wheel is driven by a 36x72-in. engine and is intended to be run at a speed of 61 revolutions. It has, however, been run as high as 76 revolutions, or a circumferential speed of over 11-3 miles per hour, and showed no indication of distortion.

Mr. Manning is building a smaller fly wheel with rim made up of ½ in. mild steel plates 24 ins. wide. The rim will be 14 ft. in diameter, 30 ins. face and 12 ins. thick. The hub and arms are of cast iron.

CENTRAL AFRICAN RAILWAY.

The English Parliament has voted in favor of the appropriation of $100,000 toward the expenses of a preliminary survey of the proposed railway from Mombasa, on the coast, to the Victoria Nyanza. The total cost of the survey is estimated at $125,000, of which the British East Africa Co. will pay $25,000. Last summer the English government and the British East Africa Co. entered into negotiations with reference to the building of this railway, and it was decided that a complete survey of the district should be made before granting a government subsidy. The vote on the question was not proceeded with last session. In the meanwhile, in order that the valuable winter months should not be lost, it was arranged with the company that the survey should be at once commenced, and the government appointed two surveyors, who are now engaged on the work. The company undertook to pay the expenses, the government undertaking to bring the subject before the House of Commons at the earliest opportunity, and to endeavor to induce the House to pass the vote. The survey has already covered 150 miles, and out of these only 15 miles were of a difficult character. The rest were comparatively easy. It is said that there is one part of the route with which considerable difficulty is expected, but that there is no reason to suppose that a railway cannot be carried the whole distance of nearly 500 miles.

The Naval appropriation bill as passed by the House authorizes the building of one new cruiser.

DIAGRAM FOR DETERMINING THE SIZE AND WEIGHT OF FLOOR BEAMS.

We present herewith a diagram, reduced from the full scale original, giving a graphic method for determining the size and weight of steel beams for fire-proof floors. The chart or diagram is printed on celluloid or tracing paper, and by placing it in position on the floor plan, the required weight and size of beams for the specified spans can at once be read off. The use of this diagram will greatly facilitate the work of architects engaged in designing the structural details of large buildings, and such a graphic system of calculation has been needed for some time, since the modern steel and iron construction of large buildings has thrown upon architects a class of calculations and designing which are rather outside of their ordinary field. The chart is the invention of Mr. C. V. Childs and Mr. F. H. Kindl, chief engineer of Carnegie, Phipps & Co., and its use has been adopted by that firm. We are indebted to Mr. Kindl for copies of the chart. The general scheme, by the construction of the proper curves, is applicable to any section of any material, as wooden joists, for instance.

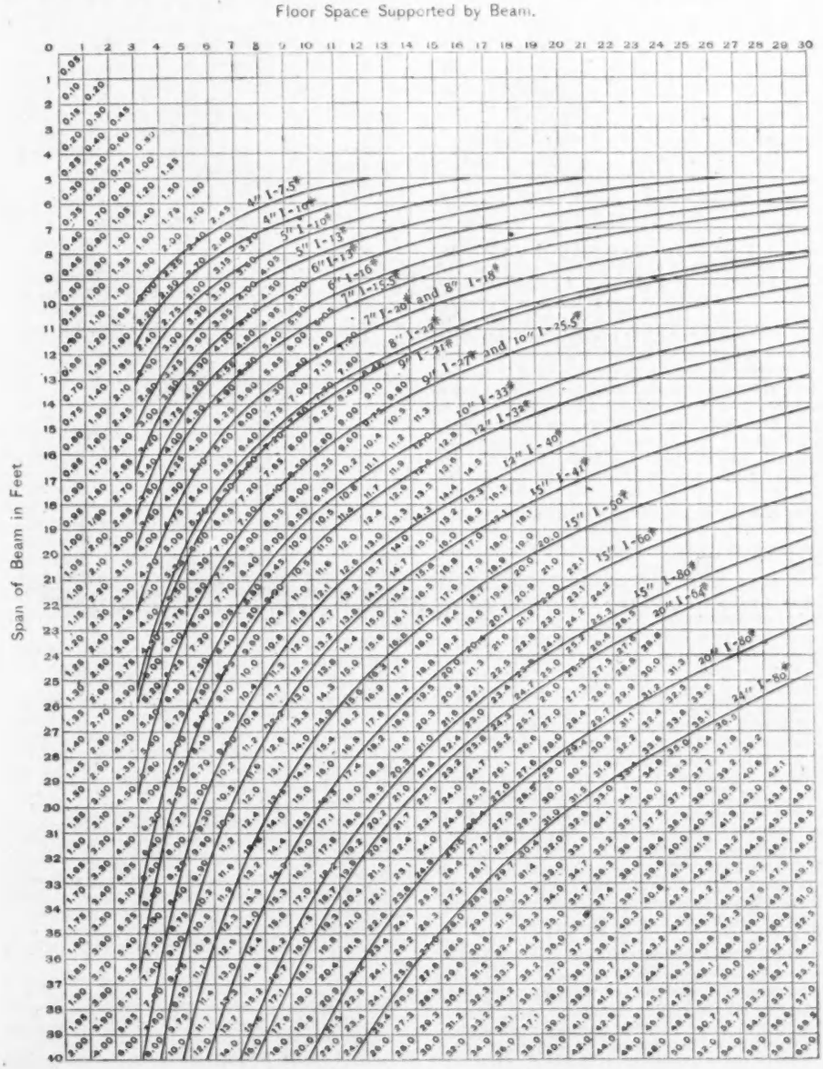
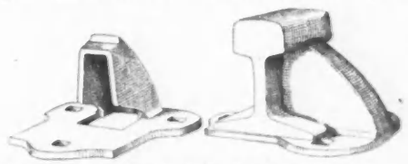


DIAGRAM FOR DETERMINING SIZE AND WEIGHT OF STEEL BEAMS FOR FIREPROOF FLOORS
Carnegie, Phipps & Co.

The directions for use are as follows: The chart is laid out to a scale of ¼ in. to 1 ft. To determine the size and weight of any beam, when the beam plan is laid out to the same scale, set the point O on the chart over one support of the beam, and note its span on the outer left hand line of chart, also note the floor space carried by the beam on the upper line of chart. Then will any of the beams, having curves to the right of and below the intersection of the lines opposite the figures above noted, be safe for a load of 100 lbs. per sq. ft. If a heavier load per sq. ft. is desired, increase the space noted in the same ratio as the loads; i. e., for 150 lbs. per sq. ft., and beams spaced 6 ft. apart, increase the spacing to 9 ft., and proceed as before. If the beam plan is laid out to the scale of ⅛ in. to 1 ft., the span and spacing, if scaled by the chart, must be doubled to conform to the same scale as the chart; for other scales of beam plans similar substitution must be made. The figures in the squares denote the load in tons on the floor area supported by the beams, for a load of 100 lbs. per sq. ft.

A COMBINATION TIE PLATE AND RAIL BRACE.

The device shown in the accompanying illustration is so simple as to need little explanation. The advantages of tie plates are coming to be well understood, and rail braces are a necessity on every road having heavy traffic and sharp curves. This combined tie plate and rail brace is intended for use in place of the ordinary brace, and chiefly, of course, for roads using tie plates on curves at least. Possibly it would give good results in place of the ordinary brace on roads where no other tie plates



The Phillips Standard Combination Tie Plate and Rail Brace.

are used, but it is at least questionable whether giving such an increased supporting power to every fourth or fifth tie would result in a smooth riding track. The brace is, of course, supposed to be made to fit the rail section. It is made of malleable iron, and the size fitting ordinary rail sections weighs about 4 lbs. The cost is from 18 to 20 cts. each, f. o. b. cars at Trenton, N. J. Some of these plates have been in service on the Philadelphia & New York division of the Philadelphia & Reading R. R. for nine months at a point where an average daily traffic of 1,605 cars pass over them, the trains being drawn by locomotives of 50 to 108 tons weight. The inventor informs us that neither the ties nor the plates seem materially the worse for the wear, and refers to the Philadelphia & Reading officers who have witnessed the test. The inventor is Mr. William H. Phillips, of Philadelphia, Pa.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Interpretation of Contract and Bond for Construction of Water-Works.

A city passed an ordinance authorizing a certain firm to construct water-works for it upon terms fully set out. This was accepted by the firm, and a memorandum of the acceptance was attached to a copy of the ordinance, and signed in behalf of the city by the Mayor and Clerk thereof, under its corporate seal, and by the firm and each member thereof under their individual seals. This constituted a binding contract. The firm gave a bond which, after reciting that the same was required of them by the city "for the faithful performance of their contract," expressed the condition to be that they should faithfully perform their contract "during the construction of said works." The latter words did not restrict the scope of the bond to the period of actual construction, but, on the contrary, a failure to begin the work at all constituted a breach. The amount of damages was at least equal to the difference between the contract price and the compensation provided for in a new contract made in pursuance of a bid, secured by a subsequent advertisement of the same work. (City of Goldsboro v. Moffete, U. S. Circ. Ct., N. C., 49 Fed. Rep., 13.)

Evidence of Surveyor as to Boundaries.

Where the location of the dividing line between the parties litigant is relevant to the matter in controversy, the testimony of the County Surveyor that he ran the line pending the suit, that defendant was present when this was done, and that a certain map of the survey is correct, is admissible evidence for the plaintiff, notwithstanding the Surveyor also testifies that his work was done in the processioning the land in accordance with the statute on that subject. That the surveyor obtained his information as to the true location of the line while engaged in processioning the tract will not affect the admissibility of the evidence. The plot was admissible to illustrate the evidence of the witness, and if the accompanying report of the processioners corresponded with this evidence, and with the plot, it was harmless; and, if it differed from the same, the contents should have been set out in the bill of exceptions. (Green v. Harris, Supr. Ct. Ga., 14 S. E. Rep., 503.)

TESTS OF STRUCTURAL WROUGHT IRON AND STEEL.

(Concluded from page 427.)

Pittsburg iron, but cannot, except in some cases, be met by Eastern mills; the third (Bridge Builders') is used more or less, but the trouble with it is that anything which any mill turns out will fill the requirements prescribed; and if the first set of test pieces are not satisfactory, a set can be obtained under these specifications which will give the desired results for the record. They are also illogical and contradictory in several points. It is well known that certain specifications, which are quite reasonable for wrought iron made in the Pittsburg district, cannot be filled in the East; and that others drawn for Eastern mills, and which would there secure first-class material, would be unsuited in the West to obtain equally satisfactory results. Still, these different specifications are used indiscriminately in the different districts, and prices are made irrespectively. Can it be surprising that trouble results?

There is no intention on my part to condemn Eastern iron. It is really good material; but I desire to call attention to the fact that it is of a totally different kind, and should be recognized as such in contracts and specifications, just as much as charcoal or Swedish iron, or high carbon and low carbon steels.

Specifications for steel have likewise given no trouble at certain mills, although others could not have filled them. But in both cases bids have been handed in without regard to requirements, and even with the positive knowledge in advance that the mills offering to supply the material had never made any having the desired qualities. The bidders trusted to good luck to get through with their contracts as easily as possible.

As a rule, mill-men know before the inspector does whether any single piece is defective or not, and they should then immediately replace it before changing rolls, and not depend upon the leniency, good nature or ignorance of the inspector to have material accepted which they know to be defective. Moreover, it is a common practice to try to force an engineer to accept a defective piece on the ground of the delay which would result from rejection. In our better mills, which make an honest effort to fulfill their contracts in a liberal manner, this case rarely arises. When material is inspected with proper promptness for surface defects and correctness of shape, any shortcomings will be detected before changing rolls, and can be rectified instantly. What are styled "excessive rejections" never occur, unless the contractor is trying to keep as close to the minimum limits as possible, and then he has himself alone to blame.

The drifting test proposed by Mr. Hunt can only be correctly made on very low steel. It is made on a rough sheared piece of scrap with a hole punched in it, and all other steels and all wrought iron are considerably and injuriously affected by punching and shearing. Further, the number of blows of the sledge, the weight, and height of fall, and rapidity of blows all affect the results more or less, and thus make them of doubtful accuracy.

Mr. Hunt criticises the hardening test on the ground that the temperature to which the steel is heated and the character of the solution in which it is quenched have an important bearing on the result. The hardening test proposed, however, is specified to be made at a "fair red heat," and the quenching is to be done by plunging in water at 70° to 75° F.

Mr. Hunt says the bending test is not a crucial test for soft structural steel, and that the nicked bending test is not applicable to steel except under special conditions. On the other hand, authorities on steel are generally agreed as to the value of bending and nicked bending tests for steel, some even going so far as to assert that chemical analyses may be omitted when such tests are properly made.

The bulging test is made and recommended by Kirkaldy alone, and is never made in this country. Hot flanging tests are made to determine the flanging qualities of boiler steels, but it is not clear how a cold bulging test can determine the qualities of the same material when hot.

Mr. Hunt nowhere mentions the drop test, yet this, when properly carried out, may be made a measure of ductility and resilience, and is probably the readiest and quickest test of these two points.

To base tests upon the melts as the units of quality, as Mr. Hunt proposes, ignores changes in the material due to reheating and working. With all the experience now available, there seems no doubt that each furnace charge of blooms or billets should be tested to determine the effect of reheating, and each largely varying shape should also be tested. A simple test, either the bending or nicked bending test, is sufficient, and the mill manager can reduce the number of tests to a minimum by charging all furnaces according to heat numbers.

Since experience has shown that certain processes are more apt to give a non-uniform product than others, the engineer has a right to specify what process he will accept material from. While the inspector has no right to interfere with the metallurgical department, his right to be present at all operations should be conceded.

There is little doubt that similar methods to those in use in continental Europe will be introduced some day in this country, but only after engineers insist upon having their specifications followed as closely as is done in work for our Government, without conceding point after point, as they are crowded by the contractors on one side and the board of managers or officers on the other. It is generally confessed that our Government always gets what is called for, and that there is no attempt to evade any number or kind of tests, although the specifications are more difficult to fill than those of any bridge or railroad engineer. This is because all the mills know that objections against the laws and principles laid down are unavailing, and that departments are immovable.

The reduction of area is considered by Mr. Hunt to be "often the best indicator of ductility." Since the reduction depends so much on local conditions and the external character of the best piece, and since its accurate measurement is exceedingly difficult, it might well be omitted.

The statement is made in the paper that iron having a tenacity of 52,000 lbs. per sq. in. is apt to be dry and incapable of welding. This is not always the case. Iron showing more than 25 per cent. elongation in 10 ins. is regularly made in the Lehigh Valley and at Pittsburg, and is the best kind of material for welding. It is not made with steel scrap, but of carefully selected muck bar, containing in some cases as much as 30 per cent. of bar made from Bessemer pig.

Mr. Hunt, in closing the discussion, said he hoped much light would be thrown on the subject of the proposed standard tests by the congress of engineers to be held at the Columbian Exposition. In reply to various criticisms he said that only four tensile tests to the carload, as proposed by Mr. Morris, would not insure the rejection of poor material. If the specification is drawn broad enough and sufficient tests are made, the acceptance of material by the inspectors should be final. There are, however, several considerations which may modify this general statement. So far as my own experience goes, with the comparatively small amount of material which I have known to be rejected subsequent to acceptance by the inspectors at the mills and shipment, the rejection has been due to one of the following causes:

1. The non-homogeneity of the steel, which has not been discovered by the few tests prescribed or permitted to the inspector to determine the quality of the material.

2. The failure of the test-requirements of the specification to develop the particular faults which the material has afterward shown.

3. Surface defects, which should manifestly condemn the material, but which have been either carelessly overlooked by the inspectors, or were so concealed at the time of inspection by ice, snow, mud, or oxide of iron scale as to prevent their discovery until after subsequent handling had developed them. The most common form of this trouble is the hidden flaws in pin-steel, which are only shown in their exact character after the pins have been turned to size; or, seams due to the "piping" at the heads of steel ingots, which have not been cropped down low enough to exclude the entire "pipe," and which are developed in the upsetting of the steel in the heads of eye-bars.

4. Mal-formed material. This is especially a cause of trouble with plates of iron and steel, such as universal mill plates warped in cooling, or with wide steel plates bent by improper handling while hot, or buckled by unskillful rolling.

I believe the ideal way of testing steel would be the supervision by the inspectors of the tests made by the manufacturers, and the further testing of crop-ends from the finished material by a standard method yet to be devised, which can be executed cheaply and readily enough to allow a large number of such tests to be made to prove the homogeneity of the metal.

In reply to the question, why should tests for steel be so much more rigid than for iron, experience shows that the quality of one melt of steel is no absolute guarantee that the next following melt, although made of the same stock, will be equally satisfactory. Again, good wrought iron ranges only from 25,000 to 27,000 lbs. in elastic limit and 46,000 to 52,000 lbs. in ultimate strength, whereas steel ranges from 27,000 to 80,000 lbs. elastic limit and from 48,000 to 120,000 lbs. in tensile strength. Moreover, steel is much more affected by hardening, cold-rolling or overheating than iron.

It is now almost universally recognized that soft steel, if properly made and of good quality, is for many purposes a safe and satisfactory substitute for wrought iron, being capable of standing the same shop-treatment as wrought iron. But the conviction is equally general that poor steel, or an unsuitable grade of steel, is a very dangerous substitute for wrought iron, even under the same unit strains.

I am already on record as not agreeing with Mr. Morris that the Bessemer is a better process for the manufacture of steel than the open hearth. My experience for the last few years further confirms my opinion, and I find the literature of the subject to favor very strongly the superiority of open hearth over the Bessemer steel, as regards particularly its uniformity. The same difference has been recognized by mose engineers in their specifications.

Nor can I agree with Mr. Morris that basic Bessemer or basic open-hearth steel should not require more careful testing than acid steel. Undoubtedly all will admit the undisputed danger of the high percentage of phosphorus in the stock used for the basic process, which has to be eliminated from the product; and to prove that it has been eliminated, a sufficient number of tests should certainly be made, beyond those required in the acid open-hearth process, where the stock used is low in phosphorus at the start. Again, to eliminate a large amount of phosphorus, it is necessary in the basic process to run the carbon very low, the fully purified basic metal carrying phosphorus down to below .01 per cent shows markedly decreased tensile strength. In order to answer requirements of 60,000 to 70,000 lbs. tensile strength in this class of steel, it is necessary to raise the carbon to a point considerably above that in acid steel of the same tensile strength. This makes a metal much more subject to hardening by cold rolling or other methods, and it requires more testing to prove the quality to be uniform.

I do not agree with Mr. Morris that "soft steel, either acid or basic, will weld as well as iron." While I admit that such material may be made to stick together with a great degree of tenacity, at the same time there is not the interlocking of the fibers of the metal due to the presence of slag, which is found in the true welding of wrought iron. I have never seen so-called "welded" pieces of steel pulled apart in a testing machine or otherwise broken at the joint which have not shown a smooth cleavage plane, as it were, such as in iron would be condemned as an imperfect weld. My experience in this matter leads me to agree with the position taken by Mr. William Metcalf in his paper upon "Steel" (Trans. Am. Soc. C. E., vol. xvi., page 301), in which he says, "I do not believe steel can be welded."

Inspectors will accept the mill tests if they see them made. There are comparatively few men available as inspectors who have had a really valuable experience in the manufacture of iron. My own experience does not show the advantage of the "practical blacksmith" as an inspector. Practical training in the mills, however, certainly should be looked for in selecting inspectors of mill materials.

Standard dimensions for test-pieces are almost impracticable, if the further condition be made that the test-pieces must be cut from the actual material to be furnished. It would be difficult to furnish a standard dimension for test-pieces, for instance, equally applicable to 2x2x¼-in. angles and 8x2-in. eye-bars.

I agree with Mr. Henning as to the inadequacy of the Bridge-Builders' standard specifications, the value of drop tests, the need of testing each reheating furnace charge, and the difference between Eastern iron, made largely from foreign ores and anthracite pig, and Pittsburg iron, made from lake ores and coke pig. At the same time the difficulties with natural gas and the greater attention paid to steel in the Pittsburg district has lessened this difference during the past year or two.

My experience has further confirmed the statement that the bending test is not a crucial test, although as an additional test it is certainly a good one. A considerable amount of material which gives in the tensile test a crystalline fracture and low percentage of reduction will bend over on itself satisfactorily. (See Eng. News, Jan. 30, 1892.)

The purification of the water of the Chicago River by injecting into it a gas which will kill the germs of corruption and render the water clear and odorless is the project of the National Antiseptic Co. The nature and manufacture of the gas are secrets, but the company claims that the water can be purified as fast as it flows out of the sewers. Some experiments have been made, but it is very improbable that any permanent effect can be made by such a process.

The bar in the river Mersey, which interferes so seriously with the shipping traffic of Liverpool, is being removed by dredging. The dredging operations have now been carried on for about 15 months with two hopper dredgers of about 500 tons capacity each, with the result that an area of about 1,000 ft. by 3,000 ft. has been lowered by 5 ft., notwithstanding that several severe gales during the year have more or less affected the work done. The amount of sand so far removed is 657,000 tons, which has been raised in 2,239 working hours. The troubles and inconveniences caused by this bar were pointed out in our issue of June 21, 1890

COMBINED RAIL JOINT AND TIE PLATE.

The joint illustrated herewith is designed primarily for first-class track, where cost is secondary to efficiency and permanency in the joints, though it is claimed that the price compares favorably with that of many other joints now on the market. The joint, as shown in Fig. 1, consists of three main

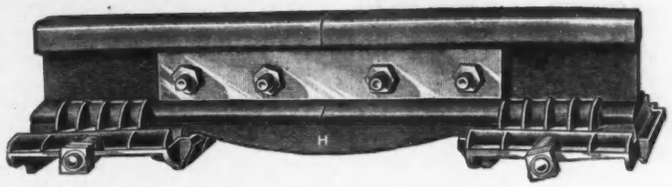


FIG. 1.

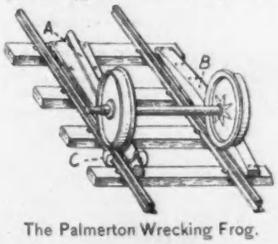
parts, all made of malleable iron—viz., the two chairs or tie plates, and the bridge plate (H), which is of channel section. The form of the chair is shown in Fig. 2. The rail is held by two clamps, the wide one moving laterally with a wedge action on the rail flange, and the narrower one being drawn up to a bearing on the flange by a bolt which lies in a groove in the rail seat of the chair. At each end of the chair is a groove to receive a lip on the end

Fig. 2.

of the bridge plate. The rails are intended to be spliced by fish-plates and bolts. The form of chair shown is intended for use with metal ties, having holes for four rivets, but experience with metal ties has shown that tie plates are not required, and it would appear as if a simpler arrangement of the joint for such ties might be designed, which would be equally effective. For use with wooden ties the chairs are made flat on the bottom, and are secured by four spikes. The weight of each chair is about 10 lbs. This joint is the invention of Mr. G. B. Fisher, Fulton St. and Milwaukee Ave., Chicago, Ill.

THE PALMERTON WRECKING FROG.

The wrecking frog shown in the accompanying cut consists of three parts, the frog (A), lifter (B) and clamp (C). The frog and lifter weigh 80 and 55 lbs., respectively, and are both made of seasoned white oak, plated with ¾-in. steel securely bolted, the intention being to combine lightness and strength. The clamp is of 1¾-in. iron and weighs 15 lbs. The



The Palmerton Wrecking Frog.

frog is held by the clamp, and by the teeth on the back end, which bite into the wood of the tie. The flange of the inner wheel of derailed truck comes on the frog between the central rib and the rail, and being drawn forward is gradually lifted and forced over onto the rail, while the outer wheel is raised till the flange clears the top of the rail, and is drawn over by the other wheel. The frog is intended for rerailing locomotives and cars, and is manufactured by Fairbanks, Morse & Co., of Chicago, Ill .

THE PROJECTED UNDERGROUND RAILWAY IN BERLIN.

This project, which has been submitted to the authorities by the "Allgemeine Electricitaetsgesellschaft" (General Electrical Co.), in Berlin, will, it is hoped, solve practically the rapid transit problem in that city. We abstract from "Glaser's Annalen" the following outline of the scheme:

The city is first to be traversed by two underground lines, running north and south, and from west to east, respectively, intersecting nearly at right angles and following the main directions of city traffic. The four quadrants thus formed are to be encircled by two concentric underground rings, or belt lines. At the intersections with the lines first mentioned and at other important points stations are to be placed.

Separate tunnels are to be driven for each track. The lines will cross either above or below each other. By using loops at the ends of the diametric underground lines, switches are unnecessary, and trains can pass from one tunnel into another without interruption. Mild steel tubes of oval section, 13-32 in. thick, 11.5 ft. high, and nearly 10 ft. wide at their lower part, driven from 26 to 40 ft. below street surface, or 6½ ft. below the bed of the Spree River, are to serve as tunnels. As the ground on which the city of Berlin is founded mostly consists of loose sand, the method of driving employed will resemble the so-called Greathead system.

The gage of the track is to be 3.28 ft. The wires of the electric conduit for supplying motive power, lighting the tunnels, etc., are placed between the rails. The trains are to consist of three vestibule cars with a seating capacity of 40 persons each, drawn by electric motors. Power is to be generated in central stations and distributed over the whole system. The trains are to run at intervals of three minutes each, with a maximum speed of 15 to 16 miles per hour.

The underground stations are to be constructed in a manner similar to the tunnels. Several tubes of the dimensions mentioned are to be placed alongside each other, and the separating walls replaced by cast iron columns. From the surface stations (either separate structures or yards and basements of suitably situated houses serving as such), passengers will descend to the stations below in elevators holding from 40 to 50 persons each.

The line to be first constructed, that running due north and south, will be about 4 miles long, of doubic track, with 14 stations. The cost of construction is estimated at $3,000,000.

Nickel is said to have been discovered in paying quantities at Riddle, Ore., and the International Nickel Mining Co. has been organized with a capital stock of $5,000,000 to work this deposit. Among the incorporators are H S. Smith (First Vice-President of the Illinois Steel Co.), of Chicago, Ill; James R. Ashley, of Joliet, Ill.; Louis T. Menage and J. B. Crooker, of Minneapolis, Minn. The company owns 285 acres of land, and it is said that the ore will assay from 12 to 25 per cent. of nickel. Plans are being prepared for a plant to cost $50,000. According to press dispatches, tests have been made by the Ordnance Bureau of the U. S. Navy Department, but the Chief of the Bureau informs us that no such tests have been made.

Five sleeping cars for the Paris and Rome service of the International Sleeping Car Co. have been built by the Midland Railway Carriage & Wagon Co., of Shrewsbury, England. The cars are 48 ft. 8 ins. long over the body, 51 ft. 7 ins. over the buffers, and 9 ft. 3 ins. wide outside, each car being supported on two four-wheel trucks. The interior finish is of polished teak, with brass antique fittings, and upholstered in figured tapestry. Each car is divided into seven compartments, with a corridor running the whole length of the carriage, connecting with a platform at each end and having a gangway communicating with the next car. Each car has sleeping accommodations for 18 persons. They are all lighted by gas, provided with lavatories, hot and cold water, and are heated by hot-water pipes extending the whole length of each side of the car, the heating apparatus being under the control of the conductor. Each compartment is furnished with an electric call for the conductor. The cars are fitted with the Westinghouse automatic brake.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

NEW YORK, ONTARIO & WESTERN.—The stockholders have approved the issue of $20,000,000 of 4 per cent. bonds, to be used partly to retire old issues of bonds and partly to purchase new equipment and to complete the terminals at Cornwall-on-the-Hudson.

NEW YORK CENTRAL & HUDSON RIVER.—The bill authorizing this company to elevate its tracks between 106th St. and 135th St. has become a law, and officials of the company state that construction will begin as soon as the necessary arrangements can be made. The bill provides that one-half of the expense of the work below the Harlem River shall be paid by the city of New York and that the work shall be done under the supervision of a Commission to be appointed by the Mayor. The work will consist of a new bridge over the river and an elevated track above and below the river in place of the present sunken one. The entire cost of the work will be about $3,000,000, and it will be completed in about 18 months.

SANDUSKY & COLUMBUS SHORT LINE.—The contract for the masonry on the extension from Bellevue, O., to Columbus, O., has been let to W. M. Brodie, of Newcomerstown, Ohio.

PORTLAND & RUMFORD FALLS.—Track laying will begin at once on the extension from Gilbertville to Rumford Falls, Me., 14 2-5 miles. Ch. Engr., Parker Spofford, Bucksport, Me.

LANCASTER, OXFORD & SOUTHERN.—The contract is reported let for building 4½ miles of this line from Child's Station, Md., on the Baltimore & Ohio R. R., north to the Providence Paper Mills, Cecil Co., Md. Arrangements are also being made to build the remaining nine miles to Oxford, Pa. It is stated that the work will be rapidly pushed to completion. Ch. Engr., S. C. Slaymaker, Lancaster, Pa.

Projects and Surveys.

READING, LANCASTER & BALTIMORE.—A Lancaster, Pa., paper states that the contract has been let for constructing 11 miles of this line from Reading to Adamstown, Pa. Ch. Engr., S. C. Slaymaker, Lancaster, Pa.

PLYMOUTH CO.—This company has been chartered in Massachusetts to build a railway from East Weymouth, Mass., on the Old Colony R. R., to Brant Rock, Mass., and also a line from a point on the first line in Marshfield township to Hanover, Mass. Among the incorporators are Ebenezer T. Fogg, Norwell, Mass., and John F. Simmons, Hanover, Mass.

NEW YORK CONNECTING.—Chartered in New York to build a railway from a point in Westchester Co., east of the Bronx River, to Brooklyn, N. Y., 10 miles. Among the directors are Oliver W. Barnes, Chas. W. Mackey, Willis R. Barnes and others, of New York city.

OTTAWA, WADDINGTON & NEW YORK.—A press dispatch from Ottawa, Ont., says: "A meeting of the directors of the Ottawa, Waddington & New York R. R. & Bridge Co. was held here to-day to consider a proposition made by Mr. Barnes, who is a consulting engineer of the Vanderbilts and who is also one of the six commissioners who hold a charter for a railway from the United States Government to connect with the Ottawa, Waddington & New York R. R. at Morrisburg. This proposition is, on certain conditions, to build within one year the bridge over the St. Lawrence at Morrisburg, joining the Canadian road with the Vanderbilt system in the United States. This depends upon the settlement of all the difficulties among the Canadian boards. It is believed that this point has been reached. So far no objections have been made to the bill now before Parliament."

ELLWOOD CONNECTING.—This company has been chartered to build the proposed connecting railway between the Beaver & Ellwood R. R. and the Pittsburg & Lake Erie R. R., noted last week, under the last named company. Pres., Jas. H. Reed, Pittsburg, Pa.

DAVENPORT, MIDDLEBURG & DURHAM.—This company has been chartered in New York to build a railway from East Davenport, N. Y., to East Durham, N. Y., 60 miles. Among the directors are Edwin M. Harris, Cooperstown, N. Y.; Jacob Neville, Middleburg, N. Y., and Benj. H. Avery, Jefferson, N. Y.

Southern.—Existing Roads.

KANAWHA & ELK RIVER.—Ch. Engr., Oscar A. Veazey, Dego, W. Va., writes us that grading has been begun on this West Virginia railway. The company was chartered about a year ago to build a railway from the mouth of Kelley's Creek up that stream to its head and thence to Sutton, W. Va. The grading and masonry will be done by the company's forces. Only five or six miles will be graded this season. The President of the company is David Ward, of Detroit, Mich., who owns coal and timber lands along the route, and the principal object of the road is to develop this and other properties along the line.

MACON & ATLANTIC.—This partly completed railway from Macon, Ga., to the Atlantic coast, will be sold at auction on May 12. The sale will cover all the roadbed, right of way and side track from Sofkee, Ga., to the Savannah River. The condition of the road is as follows: From Sofkee, in Bibb Co., to the 13th mile post in Twiggs Co., the grading is nearly completed and the right of way generally acquired, and a trestle has been constructed through the swamp of the Ocmulgee River on both sides. From the 13th mile post to Bruton in Laurens Co., a small portion of the right of way has been acquired, and a small amount of grading done. Commencing at Bruton at the intersection of the Macon & Atlantic Ry. with the Wrightsville & Tennille R. R. The line has been graded and the rails laid for 11.52 miles and a yard track constructed at Burton, all laid with 70-lb. steel rails and 52-in. angle bars. From the eastern end of the track to Pineora, in Effingham Co., a distance of 75.45 miles, the grading and trestling is almost entirely finished, a large amount of trestling being included in said distance. The distance from Sofkee to Pineora is 144.16 miles. Also all the land deeded by H. N. Feagin to the company, at Sofkee, containing about 6 acres; also 50 flat cars, 24 box cars and 1 push car; also all the franchises held and owned by the Macon & Atlantic Ry. Co. The property of the Macon & Savannah Construction Co. will also be sold at the same time. This property is as follows: 6,725 70-lb. steel rails; 28,236 angle bars;

55,250 bolts; 670 kegs of steel spikes; 51,000 washers; 2 spring frogs; 4 switches, and 292,000 cross ties.

TAVARIS, ATLANTIC & TAMPA.—It is stated that work is in progress from Tavaris, Fla., southwest toward Tampa, Fla., and that it will soon be begun from Tavaris toward New Smyrna, Fla. Geo. O. Butler, C. E., Tavaris, Fla.

MEADOW CREEK.—Ch. Engr., E. S. Hackett, of Coit, W. Va., writes us that surveys are now in progress for this West Virginia line, and that the route has not been definitely decided upon. The road is projected to open up coal lands and will not do a general freight and passenger business. The route is through a mountainous country and the work will be heavy; maximum grade 2½ per cent. and maximum curve 12°. There will be two inclines 4,600 ft. and 5,400 ft. long, respectively, with an elevation of 1,250 ft. from the railway to the coal seams. The contract for building two miles of the line has been let to Feeley & Breen, of Alexandria, Va. Tracklaying is projected to begin about July 20.

CHAMPION LUMBER CO.—This company has completed a 4½-mile logging railway near Meridian, Miss. Pres., H. S. Sweet, Orvisburg, Miss.; Ch. Engr., N. M. Brandon, Meridian, Miss.

CHARLESTON, SUMTER & NORTHERN.—The surveys have been completed for the proposed line from Bennettsville to Society Hill, S. C., 11¼ miles, and an official of the company informs us that construction will begin in 30 days and that the line will be completed in four months. The route is through a level country and construction will be quite easy. Receiver's certificates will be issued to provide funds for construction.

PICKENS.—About two miles of grading has been completed on the railway from Easley to Pickens, S. C., nine miles, and a large force is now at work. The grading is being done from Pickens toward Easley and the contractors, Burckhalter, Grandy & Co., hope to have the line completed in three months.

Projects and Surveys.

ASHEVILLE & BRISTOL.—At a recent meeting of the directors of this company the following officers were elected: Pres., Wm. M. Cocke, Jr.; V.-P., Wilson Hensley; Sec., A. R. Eskridge, and Treas., W. W. Rollins. It is stated that the company will build a railway from Asheville, N. C., to Bristol, Tenn., the work to begin as soon as the townships through which the lines will run in Buncombe Co., N. C., have voted the aid asked.

ASHEVILLE & WEAVERVILLE DUMMY.—A correspondent writes us that nothing has been done with this enterprise since last winter, and that the company is now waiting to see what will be done with the Asheville & Bristol R. R., which runs over the same route as this road. In case the Asheville & Bristol R. R. is pushed, nothing further will probably be done with this enterprise.

HALIFAX & INDIAN RIVER.—The Florida Loan & Trust Co., of Titusville, Fla., is arranging to act as trustee, and to place the bonds of this company. Its proposed line is to run from Daytona to Titusville, Fla., 45.6 miles.

MISSOURI, EAST TENNESSEE & VIRGINIA.—L. C. Wolkins, 258 Washington St., Boston, Mass., V. P., writes us that this road is projected to run from Fulton, Ky., via Nashville and Knoxville, to Bristol, Tenn., with a line from Nashville via Perryville, to Memphis, Tenn., and a line from Perryville to Elora, Tenn., a total distance of 713 miles. The company has also secured contract of the Anniston & Montgomery R. R., and will extend it to run from Montgomery, Ala., to Elora, Tenn. Three corps of engineers are now at work and the surveys are well on toward completion. The work will be heavy from Knoxville to Smithville, Tenn., but on other sections it will not be unusually difficult. The maximum grade is 1½ per cent., and the maximum curve 2°. There will be a bridge at Perryville, Tenn., and one tunnel about one-third of a mile long. The contract has been let to a construction company, and it is expected to have the entire line completed by May, 1894.

SHELBYVILLE, NASHVILLE & NORTHERN.—Pres. G. C. Sandusky, Shelbyville, Tenn., writes us that it is hoped to let contracts for building this road this season. The line will be 54 miles long and will run from Shelbyville to Nashville, Tenn., 54 miles. Ch. Engr., Wm. B. Ross, Nashville, Tenn.

KANAWHA VALLEY.—A correspondent writes us that this road is projected to run from Parkersburg to Burnesville, W. Va., 120 miles, and that surveys will begin during the summer. The route will be along the bottom lands for its whole length, and the maximum grade will not exceed 50 ft. per mile. About $200,000 have been promised by the towns along the route. Pres., C. H. Shattuck; Ch. Engr., Thos. Pettigrew; both of Parkersburg, W. Va.

TAMPA SUBURBAN.—This company has been chartered in Florida to build railways in Tampa and Hillsborough counties. The officers are: Pres., W. H. Kendrick; Gen. Man., and Treas., E. S. Douglas, and Sec., P. O. Knight.,

Northwest.—Existing Roads.

WABASH, CHESTER & WESTERN.—A correspondent writes us that work has just begun with a force of 150 teams on the Tamaroa & Mt. Vernon Ry., from Tamaroa to Mt. Vernon, Ill., 22 miles. N. W. Irish & Co. have the contract for the grading and Taylor & Lutes have the contract for the trestling. It is expected to begin tracklaying about August and to have the line completed by October. Ch. Engr., Robert Moore, Laclede Building, St. Louis, Mo.; Res. Engr., E. A. Wilder, Tamaroa, Ill.

CANADIAN PACIFIC.—Among the proposed extensions of this company for this year are the following in Manitoba and the Northwest Territory: An extension of the Souris Branch from Oxbow west 40 miles; an extension of the Deleraine Branch to a connection with the Souris Branch, 18 miles, and an extension of the Glenboro Branch to Souris, Man., 18½ miles.

BURLINGTON, CEDAR RAPIDS & NORTHERN.—Contracts will be let at once for 10 miles of the proposed extension from Forest City to Esterville, Ia., 40 miles, and the entire line will probably be built this year.

JACKSONVILLE SOUTHEASTERN.—Ch. Engr., J. S. Olmstead is reported as saying that the contracts had been let for 20 miles north from Havana, Ill., on the proposed extension from Havana to Rock Island, Ill. Surveys are in progress along the entire extension and it seems probable that work will begin soon.

DULUTH & IRON RANGE.—The contracts for building 16 miles of the branch to the iron mines of the Mesaba range has been let to Winston Bros., of Minneapolis, Minn.

Projects and Surveys.

SPRINGFIELD, SEDALIA, MARSHALL & NORTHERN.—H. N. Armstrong, Consult. Eng., Brookfield, Mo., writes us that the surveys and estimates for this proposed railway from Springfield, Mo., to Miami, Mo., 184 miles, have been completed, and that negotiations for the capital necessary to construct the line are now pending. There will be a bridge over the Osage River. In connection with the above, Mr. Armstrong also furnishes us with the following information in regard to the Brookfield & Northern and Iowa Extension railways, which are portions of the same line. These two roads will form a continuous line from Miami, Mo., to Centerville, Ia., 111 miles. The surveys have been made. The maximum grade will be 48 ft. per mile and the maximum curve 8°. There will be bridge over the Missouri River 3,200 ft. long, exclusive of approaches, for the construction of which a charter has been secured from the United States Government.

DULUTH & NORTHWESTERN RY. & TERMINAL CO.—It is announced that this company will be chartered to build railway terminals at Duluth, Minn. The plan includes a transfer railway line, a tunnel under the ship canal, bridges to Superior and Old Superior, ore docks and other terminal facilities. The company pledges itself to begin work within 30 days after the passage of the ordinance by the City Council.

FT. DODGE & NORTHWESTERN.—At a recent meeting of the stockholders of this company the following officers were elected: Pres., Hamilton Brown; V.-P., Thos. W. Carpenter, and Sec. and Treas., C. Garrabrant. The company proposes to build a railway from Fort Dodge to Story City, Ia.

Southwest.—Existing Roads.

PAN AMERICAN.—About five miles of track have been laid from Victoria, Tex., south and it is expected to have ten miles completed by May 1.

AUSTIN & NORTHWESTERN.—Tracklaying has been completed from Fairland, Tex., to the Colorado River on the Fairland-Llano extension, and as soon as the temporary bridge over the river is finished it will be pushed rapidly to Llano, Tex.

HOUSTON & TEXAS CENTRAL.—The people along the route are trying to induce the company to build a line from Burnet to Lampasas, Tex., about 20 miles.

TEXAS, LOUISIANA & EASTERN.—A press despatch from Houston, Tex., says: "Mr. John P. Irvin, one of the stockholders of the Texas, Louisiana & Eastern Ry. in this city, is to-day in receipt of a letter from the President, Wm. C. M. Putnam, now in Chicago, stating that he has placed $150,000 worth of bonds of the company, and is now in condition to push the work on the road from Conroe to the Trinity River, a distance of over 40 miles. From Manager Smith, in charge of the enterprise here, it is learned that the company has already graded 23 miles and has 7½ miles of track laid. He is confident that they will be able to connect with the Houston, East & West Texas Ry. by June 1, and will reach the Trinity by fall. The road has passed through an undeveloped pine forest of the best material, and its benefit to that section of the country in the matter of development will be wonderful. Mr. Smith says the work will be pushed rapidly ahead."

KANSAS CITY, WATKINS & GULF.—This line will be completed to Alexandria, Ala., by May 1.

Projects and Surveys.

HOXIE & POCAHONTAS.—Chartered in Arkansas to build a railway 35 miles long, from Hoxie, Ark., to a point in northern Arkansas. The officers are: Pres., J. H. Moran, Walnut Ridge, Ark.; V.-P., Wm. D. Gentry, Chicago, and Sec. and Treas., John T. Gibson, Black Rock, Ark.

Rocky Mt. and Pacific.—Existing Roads.

EVERETT & MONTE CHRISTO.—About 800 men are now at work on the first 15-mile section of this railway from Getchell, Wash., east, and that the rock work in the Stillaguamish Canyon has begun. In three miles of this part of the line there are five tunnels, the longest of which is 825 ft.

GREAT NORTHERN.—A press dispatch from Spokane, Wash., contains the following information in regard to the progress of work on the Pacific extension: "Mr. Siems, of Shepard, Siems & Co., arrived in Spokane from the East April 16. The progress of the work on the Great Northern, he says, is very satisfactory. The gap between Bonner's Ferry and Calispel, Mont., will be closed by May 1, there being now only 20 miles of track to lay. The bridge at Albany Falls will be completed about April 25, and possibly as late as May 1. There are 49 miles of track to lay between Spokane and Albany Falls, which will be completed and trains running into Spokane by June 1. The contracts have been let and grading is under headway on all but about 30 miles of the route between Spokane and the Columbia, and that will be commenced as soon as definite location is made. As soon as work is completed on this side of the Columbia, work will be commenced from that point on west to the summit of the Cascades, a distance of about 50 miles. The intention is to have the two construction forces meet on the summit of the mountains. Then the line will be completed to the coast with the exception of the tunnel through the Cascades. While the tunnel is being cut through the mountain will be traversed by means of a switchback. Teams, outfits and all the necessary appurtenances and men are now in Spokane and will go to Wenatchee immediately and begin the construction of a wagon road from Wenatchee to the summit of the Cascades, to be used by the Great Northern in getting supplies to this point."

Projects and Surveys.

BUCKSPORT & ELK RIVER.—Surveys have been completed for a 4-mile railway from the mouth of the north fork of the Elk River to Bridge Creek, in Nevada. Ch. Engr., Frank Herrick, Humboldt, Nev.

TOLMAN'S & VALLECITOS.—Chartered in California to build a railway from Tolman's Landing, Fresno Co., to Vallecitos, Cal. Among the incorporators are Geo. B. Tolman, H. M. Shaw and Alfred S. Moore.

GREELEY, ST. VRAIN & DENVER.—The surveys have been completed for this proposed railway from Greeley, Colo., to Idaho Creek, Colo., on the Burlington & Missouri R. R., and the profiles and estimates are now being made. The road will be 28 miles long, and will probably be built by the Burlington & Missouri River R. R. Co. Ch. Engr., John S. Titcomb, Denver, Colo.

FLORENCE, CRIPPLE CREEK & STATE LINE.—The surveys have been completed for this railway from Florence, Colo., north to the Cripple Creek mines. The line as surveyed is 39.2 miles long, and runs from Florence to Fremont, Colo. The line is very favorable, considering the character of the country, the maximum grade being 4 per cent. and the average grade only 2 per cent. There will be no tunneling and only six bridges of any length.

SIUSLAW & EASTERN.—The people along the route of this proposed Oregon railway are evincing considerable enthusiasm and there are some prospects that the line will be built soon. The road is projected to run from Siuslaw to Eugene, Ore., 50 miles, and $100,000 local aid is asked by the company. Ch. Engr., T. R. Berry, Eugene, Ore.

CALIFORNIA MIDLAND.—Two parties of engineers are now at work on this California railway from Stockton, Cal., south to Visalia.

Foreign.

MEXICO.—President Diaz, in his recent address to the Legislature, refers to the railways in the following terms: "The increase of our railway system (since September) amounts to more than 300 kilometers. The railways on which the most noteworthy progress has been made are: the Mexican Southern, which has reached Tomellin; the Central's new branch, which is now in operation between Tula and Pachuca; the International, which is rapidly advancing toward Durango; and the Peninsular Railway of Lower California, of which more than ten kilometers are already completed. The active work being done on the Hidalgo and Yucatan railroads is also worthy of mention."

ELECTRIC RAILWAYS.

NEW BEDFORD, MASS.—The Union Street Ry. Co. has sold a majority of the stock to the New York Equipment Co., and it is expected that electric traction will be adopted.

NEWARK, N. J.—The New Jersey Traction Co. is applying for a franchise for an electric railway to Elizabeth.

PHILADELPHIA, PA.—The Philadelphia Traction Co. expects to begin work shortly on the trolley system.

CHESTER, PA.—Chester & Media Electric Ry. Co.; $100,000; $10,000 paid in. Pres., S. A. Dyer, Chester.

ROCHESTER, PA.—Rochester & Beaver Electric Street Ry. Co.; $60,000; $12,000 paid in. Pres., A. T. Anderson, Beaver.

HAGERSTOWN, MD.—The Lewis-Mercer Construction Co., of New York, has applied for a franchise for an electric railway.

WASHINGTON, D. C.—Proposals for the construction and equipment of the Washington, Alexandria & Mt. Vernon Electric Ry. have been advertised to be opened on April 22, but it was decided to give the bidders a few more days, as hardly enough notice was given to enable them to collect the necessary information. The road is to be about 12 miles long, single track, with standard 60-lb. T-rails, except within the city limits of Alexandria, Va., where girder rails will be used. The route is from the railway stations and ferry wharves in Alexandria, along the crest of the ridge overlooking the Potomac, to the tomb of Washington at Mt. Vernon. A pile trestle, ½ mile long, will carry the track, and a double roadway and sidewalk across Hamburg Creek. The entire line is expected to be completed by August. Mr. F. H. Stier, of Washington, is Chief Engineer.

MUNCIE, IND.—Muncie Electric Ry. Co.; $100,000; W. L. Little, R. C. Griffith and John M. Kirby. The trolley system will be used, and several suburban lines built.

MONTEREY, MEXICO.—A company has been organized to acquire the five street railway lines and equip them for electric traction. The concessionaires are Henry Oliver, Frank Brown, Jr., and Dr. Carlos Welsh; and among the capitalists are O. C. Crocker, and Geo. F. Furr.

MONTREAL, QUE.—The city will receive proposals for electric street railway privileges until May 17. A proposition to build an electric railway on the trolley system has been made by R. A. Mainwaring.

ELEVATED AND CABLE RAILWAYS.

BALTIMORE, MD.—The Lake Roland Elevated Ry. Co. has been incorporated as a consolidation of the North Avenue Electric Ry. Co. and the Baltimore, Hampden & Lake Roland Ry. Co.; $1,000,000. Pres., Wm. H. Whitridge; Vice-Pres., Jesse Hilles; Secy., E. H. Bouton. The City Passenger Ry. has awarded contracts for boilers for the new cable plant to the Campbell & Zell Co., of Baltimore.

CHICAGO, ILL.—The Lake Street Elevated Ry. Co. has increased its capital stock from $3,000,000 to $5,000,000, and has adopted an extension of its proposed route on Milwaukee and Blue Island Aves. to Oak Park.

HORSE RAILWAYS.

NEW YORK, N. Y.—West Side Ry. Co., 5 miles, from W. Twenty-third St. ferry to Riverside Park; $100,000; W. W. Newcomb, A. L. Martin, John G. Hyatt and F. S. Smith.

RED BANK, N. J.—Red Bank & Seabright Street Ry. Co.; $50,000; C. S. Hobart, J. W. Chandler and W. W. Conover.

PHILADELPHIA, PA.—Boulevard Passenger Ry. Co.; $18,000; Pres., Edward J. Moore, Germantown, Pa.

WILLIAMSPORT, PA.—Center West End Passenger Ry. Co.; $18,000; Pres., Elias Deemer.

HIGHWAYS.

RHODE ISLAND.—The town of Cranston has voted $50,000 for macadamizing highways, $5,000 for a steam roller, and $2,500 for stone crusher and power.

MICHIGAN.—A stone road 2½ miles long, will be built by private enterprise. P. A. O'Donnell, John Scanlan and C. R. Spencer are interested.

MISSOURI.—Proposals for macadamizing Highland Ave. will be received until May 4 by F. J. O'Flaherty, County Surveyor, St. Louis.